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ABSTRACT

The course materials included in this guide are intended to introduce students to the manufacturing industry and its relationships with society, individuals, and the environment. The following topics are covered in the nine learning modules: manufacturing and society and manufacturing systems; manufacturing materials and processes (types of materials and their properties, ways of obtaining resources, and production of industrial materials); parts manufacturing processes (concepts and practices related to casting, forming, and separating); parts and product completion processes (concepts and practices involved in conditioning, finishing, and assembling); organizing, financing, and managing an enterprise (forming and staffing an enterprise, raising capital, and maintaining financial records); researching and developing products (establishing product criteria, designing and sketching ideas, and specifying designs); producing products (selecting and sequencing operations, developing tooling, establishing quality control programs, designing safety programs, and conducting pilot and production runs); marketing products (promoting and selling products); and closing an enterprise. Each module includes information about the length of time needed to complete the module, an introduction to the instructional content to be covered in class, performance objectives, a day-by-day outline of student learning activities, related diagrams and drawings, and lists of suggested textbooks and references. (MN)

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TECHNOLOGY EDUCATION COURSE GUIDE

INDUSTRIAL ARTS/TECHNOLOGY EDUCATION

DIVISION OF VOCATIONAL EDUCATION
STATE DEPARTMENT OF PUBLIC INSTRUCTION
RALEIGH, NORTH CAROLINA 27603-1712
1988

U.S. DEPARTMENT OF EDUCATION
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MANUFACTURING SYSTEMS

GRADES 9-10

COURSE #8115
(SEMESTER)

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ACKNOWLEDGEMENTS

The North Carolina Technology Education Curriculum is the product of a curriculum redirection process begun in the early seventies. As in any change process, many individuals have contributed their time and energies to provide North Carolina students with a curriculum designed to meet their needs to be technologically literate adult citizens. The following are recognized for their vision and leadership in setting the direction for Technology Education in North Carolina schools.

Members of the N.C. Curriculum Study Taskforce who charted the course for technology education in North Carolina schools. Their study report and recommendations provided the direction for a change in the identity of the discipline and a total redirection of the curriculum.

Members of the N.C. Curriculum Committee who validated the Technology Education Curriculum Guide as appropriate study for assisting students in understanding technological systems impacting on their lives. Further, industry representatives of the committee verified the appropriateness of suggested activities reflective of practices in construction, communications, manufacturing, and transportation.

N.C. Technology Education Association who provided a forum for redirection of the discipline. It was the association that led the profession in changing identity to technology education. The association also provided opportunities for professionals to develop competence in the classroom delivery of technology education through the sponsorship of in-service programs.

Individual technology education professionals who gave leadership to other professionals in the curriculum change process. These professional leaders piloted many technology education activities in their classrooms and served as role models for other professionals.

Members of the N.C. Council of Technology Teacher Educators who provided insite and support throughout the curriculum redirection process.

Indiana curriculum developers who provided curriculum materials adopted and adapted for North Carolina Technology Education programs.

INTRODUCTION

The North Carolina Technology Education Curriculum is a program to meet every citizen's need to be technologically literate. Some basic assumptions underlie the program, and these can be divided into content assumptions, and learner assumptions.

The curriculum was developed using the belief that the appropriate content for the field is technology, and its impact on individuals and society. It was further assumed that the content is best organized around human productive systems that have been used, are now being used, and will, most likely, continue to be used. These universal systems are communication, construction, manufacturing, and transportation. Finally, it was assumed that this content can best be addressed from a systems approach with its inputs, processes, outputs, feedback, and goals/restraints.

The curriculum was further based on the assumption that education should meet the needs of individuals and the human requirements of society. It was assumed that each person living in a technological society should have a basic understanding of and the ability to assimilate the knowledge about technology. People it was assumed, should be able to interact with the technological nature of society and help impact the type of future new technologies can provide. Additionally people should be able to be contributors to a society in their several roles, including citizen, voter, investor, consumer, worker, and leader.

These assumptions caused the curriculum to be developed in such a way as to:

1. Provide an overview of technology first, allow for more indepth study in specific technological areas, and culminate with synthesis activities.

2. Be more teacher-directed, content-centered in early courses, and highly, student-directed, process centered in advanced courses.

3. Involve problem-solving and group activities of all courses.

4. Stress the how and why of technology and its relationship to our quality of life.

5. Be activity-centered learning, with the content being used to determine the appropriateness of each activity selected.

6. Be equally important to young women and young men, both of which must function in a technological society.

Finally, the curriculum was developed to be descriptive rather than prescriptive. The materials describe what to teach and suggest ways of teaching the content. At no time are daily activities prescribed in such a way to preclude individualizing the presentations to meet local conditions.

THE CURRICULUM GUIDE IN AN INSTRUCTIONAL SYSTEM

Each course in the North Carolina Technology Education Curriculum is seen as a dynamic activity involving a complete instruction system. This system generally includes seven components: the teacher, the students, a texbook when available, the curriculum guide, laboratory sheets, apparatus, and a reference library.

THE TEACHER

The teacher plays the primary role in the system. This role entails being a curriculum developer. The teacher chooses the points to emphasize and to evaluate. Care should be taken to insure that the coverage of the subject is comprehensive. You should resist "picking and choosing" only modules and activities that are the most interesting, most familiar, or the easiest to implement. All modules and activities should be included. However, you are encouraged to redesign or replace activities with your own activities that contain equivalent content.

As a technical expert, the teacher gives presentations, demonstrations, and asks questions about the subject matter. Safety information, and the demonstration of teaching/learining activities, are the responsibility of the teacher.

The teacher is an instruction manager. Managers plan, schedule, direct, and control activities. The teacher, perhaps in cooperation with students, plan the instruction by identifying the instructional goals. The activities to reach these goals are scheduled. Through presentations and application activities students are directed through the construction activities. Finally, the student's work and the teacher's management is controlled through various forms of evaluation. Since evaluation instruments should be designed to measure success in reaching the goals, these instruments should be prepared by the teacher.

The teacher is the creator of the teaching/learning environment. It is highly recommended that you create a "role playing" environment. In addition to having students do tasks that simulate construction, have them play the role of workers, managers, and owners. For example, refer to a group of students as a "work crew" or "survey party" with job titles, rather than as students who carry out assigned tasks. Help them visualize themselves in their roles. The teacher can become a job superintendent, owner, or government officer, who approves the "work crew's" job.

THE STUDENT

The target population is made up of middle-junior high or high school students. The students will often work in groups of from three to five. Their responsibilities include reading the textbook assignments, doing the worksheets as homework, and completing the activities.

THE TEXTBOOK

A textbook should be selected for the course and each student should have one. A textbook contains the body of knowledge about industrial technology. It should be selected to meet the appropriate reading level, and be written in an interesting way with numerous illustrations.

THE CURRICULUM GUIDE

The curriculum guide is to be used to help plan your instruction. The introduction consists of a structure for the content and a description of an instructional system with suggestions on how to use it.

The remainder of the curriculum guide briefly describes the modules. Each module consists of an introduction, objective(s), and a description of the activities. The description of the activities includes a schedule, presentation titles, application activities, and presentation titles, references, and safety guidelines. Suggestions for getting prepared and carrying out the activity are found in the teacher activity sections.

Suggestions for a variety of optional activities may also be found throughout the curriculum guide.

THE APPARATUS

Often the course guide contains plans for specialized apparatus useful in teaching the course. Drawings will be placed with the activity in which they are used. You can use the drawings to construct the apparatus.

THE REFERENCE LIBRARY

Some courses require student reference books. The titles of these are included in the reference library and copies should be purchased for laboratory use.

DAILY LESSON PLANS AND EVALUATION

The planning of daily activities and an on going evaluation system are th teacher's responsibility and rightfully so. Each student should adapt activities and presentations to insure they help students develop the identified concepts within local conditions. The curriculum guide was designed to help you, the local professional, present a relevant, exciting course. Good luck!

COURSE OUTLINE

Module Number	Title and Content	Time (Days)
1.	Introduction to Manufacturing Manufacturing and society The manufacturing system	5
2.	Manufacturing Materials and Processes Types of materials Properties of materials Obtaining resources Producing industrial materials	10
3.	Parts Manufacturing Processes Casting and molding concepts and practices Forming concepts and practices Separating concepts and practices	15
4.	Parts and Product Completion Processes Conditioning concepts and practices Finishing concepts and practices Assembling concepts and practices	9
5.	Organizing, Financing, and Managing an Enterprise Forming and staffing an enterprise Raising capital Maintaining financial records	5
6.	Researching and Developing Products Establishing product criteria Designing and sketching ideas Specifying designs	11
7.	Producing Products Selecting and sequencing operations Developing tooling Establishing quality control programs Designing safety programs Conducting pilot and production runs	17
8.	Marketing Products Promoting products Selling products	-
9.	Closing the Enterprise and the Course	3

INTRODUCTION

This course provides students with an introduction to manufacturing industry practices and their relationships with society, individuals, and the environment.

Industrial and technological activities can be grouped under four major human productive activities: communications, construction, manufacturing, and transportation. Humans throughout history, have made tools and other objects, built shelters and other structures, exchanged information and ideas, and moved themselves and their possessions.

All of these activities depend on manufacturing—the producing of goods in a factory. Communication activities depend on manufactured equipment—printing presses, cameras, television receivers, and supplies--paper, photographic film, chemicals, and recording tapes. Construction uses manufactured tools and equipment to fabricate and install manufactured materials—lumber, cement, glass, and manufactured products—windows and doors, kitchen fixtures, and furnaces. Transportation delivers manufactured products with manufactured vehicles.

An understanding of manufacturing provides a base for technological literacy and competence. This understanding is developed through the study of the two major technologies utilized by all manufacturing enterprises—materials processing and management technology.

A study of materials processing includes presentation of the types, characteristics, and properties of metallic, ceramic, polymeric, and composite materials, as well as the investigation of the manufacturing processes used to secure resources. It also includes changing them into standard stock and finished goods.

The modules in this course are organized to introduce the students to the area of manufacturing, then, allows them to study materials and the primary and secondary processes used to convert raw materials into finished products. Finally, the managed activities which are used to change a designer's idea into a marketed product are explored.

OBJECTIVES

Upon completing this course, each student should understand the following:

1. The historical background, contributions, and problems of the manufacturing industries and how these factors effect individuals and the society.

2. The various methods used to process raw materials into industrial and consumer products.

3. The nature, characteristics, classifications, and properties of common engineering materials.

4. The managed activities used to develop, engineer, produce, finance, and market a product.

5. Inputs to manufacturing—machines, energy, materials, information, people, and finances and their wise use in manufacturing.

6. Manufacturing as a technical adaptive system designed by people to efficiently utilize resources to produce industrial and consumer products in a factory.

TEXTBOOKS

Fales, James, et. al., Manufacturing: A Basic Text for Industrial Arts, Peoria, IL, Bennett & McKnight Publishing Co., 1980. (Textbook and Teacher's Guide.)

Wright, R. Thomas, Exploring Manufacturing, South Holland, IL, Goodheart-Willcox Co., 1985. (Textbook, Teacher's Guide, Student Manual and Activity Sheets.)

REFERENCES

Jambro, Donald J., Introduction to Manufacturing, Albany, NY, Delmar Publishing Co., 1982.

Kazanas, et. al., Basic Manufacturing Processes, New York, McGraw Hill Book Co., 1981.

Wright, R. Thomas, Processes of Manufacturing, Sough Holland, IL, Goodheart-Willcox Co., 1987.

MODULE: 1 : Introducing Manufacturing

LENGTH: 5 DAYS Manufacturing CLUSTER

This module is designed to let the student know the importance of studying manufacturing and how it relates to their lives now and in the future. A general overview of the course will be presented by the instructor. The instructor has an important role in presenting the material. His or her attitude must be positive and contain no bias toward the students. Remember, a good manufacturing course depends on a lot of different talents. It is important to use that pool of skills and talents to its fullest.

The new curriculum was developed for concepts to be carried from one course to the next. Your course materials will be introducing concepts which will be used in the "Material Processing" and "Production Systems" courses. Review the four industry clusters (Manufacturing, Construction, Transportation, and Communications) with the class. Stress that construction and manufacturing are similar, but their location of work is different. Construction work is done on site, and manufacturing is done off site. Communications and transportation industries are very important to efficient production needs.

Explain how the use of mass production techniques have changed our way of life for the better, and in some cases, the worse. Give the students some historical background information about the development of manufacturing. Include such historical periods as the European and American Industrial Revolutions and people such as James Watt, Elias Howe, Eli Whitney, Samuel Colt, and Henry Ford.

Define the term "enterprise" as a risky undertaking. Explain to them what it means to live in a "free enterprise system" society. Make students aware that these freedoms are open to them. Be sure the students understand that companies come in all sizes.

A manufacturing enterprise has a conceptual flow from idea to finished product. Introduce that concept to the students without going into great detail at this time. All manufacturing systems have inputs, processes, and outputs. Discuss these in general with the class. The systems will lead you into Module 2, "Material Processing Concepts."

Before going to material processing, run a teacher directed production line. This activity should be quick—one to two days in length. Incorporate tool/machine usage and safety while demonstrating each production job assignment. The production activity will give the students hands-on experience and knowledge of how a production line works. You can also use it for examples later on in the course; i.e., jigs and fixtures in the production module.

OBJECTIVES

Upon completing this learning module, each student should be able to:

1. Understand the historical background, contributions and problems of the manufacturing industries, and how these factors affect their lives.
2. Develop an understanding of manufacturing as a technical adaptive system designed by people to efficiently utilize resources to produce industrial, consumer, and military goods off site.
3. Know that the United State's economy works on a free enterprise basis while other countries do not.
4. Be aware of the conceptual model of a manufacturing enterprise (idea-activities-profit).
5. Realize the inputs-processes-outputs of a manufacturing system.
6. Participate in a teacher directed production activity.
7. Gain skills when using tools and/or machinery related to the activities.
8. Transfer knowledge gained from other classes or learning situations and apply that knowledge to the activities.

CALENDAR

DAY	ACTIVITY
1	Class orientation.
2	Review and introduction to industrial technology. Discussion of the four cluster areas of: manufacturing, construction, communications, and transportation.
3	Discussion of manufacturing and its role and effects on society. Daily activity also includes an introduction to sketching, a bill of materials, operation sheets, and a general discussion of manufacturing inputs, processes, and outputs.
4	Development of a plant layout and arrangement of facility to reflect that plant layout. Daily activity also includes the demonstration of all production jobs, safety procedures, and assignments for teacher directed production run.
5	Supervise and conduct production run for teacher directed production activity.

PRESENTING THE MODULE

DAY	ACTIVITY
0	Before you introduce this module: develop or update your daily lesson plans, generate handouts, collect examples, select media and materials necessary to support your instruction, and determine activities capable of supporting the module content. Read several teacher resources and the student textbook. Some suggested readings are: Exploring Manufacturing: pp. 7-20 and 253-256 Manufacturing (Fales): pp. 8-27 Manufacturing (Wright): pp. 13-37 Intro to Manufacturing: pp. 1-18 Basic Manufacturing: pp. 10-17. Note: A bibliography is listed in the appendix. Also, keep current with other sources of information such as magazines, professional publications, professional meetings, and other local school systems. Develop meaningful activities and experiences which will support the concepts of this module. An activity should not be lengthy, but a variety of activities should be presented to the students. Prepare activity sheets to facilitate better learning. Obtain and/or prepare materials for selected classroom and laboratory activities. Remember, this is a curriculum guide. Some modifications will be necessary to meet your specific needs. Constantly, you should evaluate and update activities and instructional materials.
1	Class orientation—orient the students to the rules and regulations of the school and department. Discuss subjects such as: attendance requirements, safety procedures, methods of evaluation, course objectives and goals, proposed course activities, and experiences, etc. Students should fill out appropriate school forms, and participate in discussion. This might be a new type of course for your students, so take time to answer questions.

DAY	ACTIVITY
1	Make note of special supplies needed, such as notebooks, etc. Review and file materials regarding requirements and policies of the course. Always have policies written out and available to students. Read textbook assignment.
2	Review the importance of previous Industrial Technology course(s) and how they relate to this course. It is also important to tell about the need to use knowledge from other subjects, such as: math, science, etc. Review the four clusters: manufacturing, construction, communications, and transportation. Discuss the development of manufacturing. Humans have always produced goods to meet their needs. The system has changed. The four major changes are the hunting and fishing, agricultural, handicraft, and industrial periods. We are now entering the technological period. (Alvin Toffler: The Third Wave). Show the video "The Challenge of Manufacturing" by the Society of Manufacturers.
3	Discuss what manufacturing means to society and how it relates and affects their life style. Some points are: 1. career decisions 2. self-understanding 3. responsible citizen 4. consumer, craftsperson, problem-solver, organizer. Develop and demonstrate sketching of and a bill of material for a teacher-directed product. Discuss in general the inputs (materials, human, capital, finance, knowledge, and energy); processes (material processing and management); and outputs (industrial, consumer, military goods and ancillary "waste") of a production system. Develop and demonstrate how to make operation sheets for the teacher directed product.

PRESENTING THE MODULE - Continued

DAY	ACTIVITY
	Students should participate in the discussion about manufacturing, soit, nd the inputs-processes-outputs of a production system.
	Relate their family's life style and future with the developments of manufacturing.
	Generate sketches (w/ 1/4 grid paper) and bill of materials of a selected product. They should sketch and dimension the product as the instructor describes it, then a bill of material is developed through class interaction.
	Read textbook assignment.
4	Arrange the machinery and table, attach jigs and fixtures, and place prepared materials for the production line before class starts.
	Demonstrate production jobs, safety procedures, and assign students to a task. Do this as quickly as possible.
5	Supervise production run.
	Complete manufacturing of the product.
	Distribute products to each student.
	Review major points and relate them to the activities.

APPENDIX

Instructional Materials:

1. Teacher developed and/or commercially available transparencies/slides/16 mm or video films/filmstrips/charts, etc., describing the four clusters, development of manufacturing, and inputs-processes-outputs of a production system. Some sample sources are:

   a. Modern Talking Picture Service
   b. Manufacturing Forum
   c. DCA Educational Products, Inc.
   d. Creative Learning Systems, Inc.

2. Developed or updated instructor's daily lesson plans.

3. Course syllabus.

4. Handouts and activity sheets on:

   a. course description and goals
   b. instructor's policies
   c. bill of materials form
   d. operation sheets.

Special Equipment and Supplies:

1. Machines needed for teacher-directed production (varies with product idea).

2. Jigs and fixtures needed for production line.

3. Materials needed for production of a teacher-directed product.

4. Simple packaging materials such as sandwich bags, with a label to illustrate packaging.

5. Safety equipment necessary for observing and performing activities.

Textbook Resources:

Fales, James, et. al., Manufacturing, A Basic Text for Industrial Arts, (1980), McKnight & McKnight Publishing Co., Bloomington, IL.

Jambro, Donald J., Introduction to Manufacturing, (1982), Delmar Publishing, Inc., Albany, NY.

Kruppa & Lindbeck, Basic Manufacturing, (1985), Bennett & McKnight Publishing Co., Peoria, IL.

Wright, R. Thomas, Exploring Manufacturing, (1985), Goodheart-Willcox Co., Inc., South Holland, IL.

Wright, R. Thomas, Manufacturing: Material Processing, Management, Career, (1976), Goodheart-Willcox Co., Inc., South Holland IL.

Publications:

Manufacturing Forum, Department of Industry and Technology, Ball State University, Muncie, IN.

The Technology Teacher, 1919 Association Dr., Reston, VA 22091.

TEXTBOOKS

Fales, James, et. al., Manufacturing: A Basic Text for Industrial Arts, Peoria, IL, Bennett & McKnight Publishing Co., (1980), (Textbook and Teacher's Guide), pp. 8-27.

Wright, R. Thomas, Exploring Manufacturing, South Holland, IL, Goodheart-Willcox Co., (1985), (Textbook, Teacher's Guide, Student Manual, and Activity Sheets), pp. 7-20; 253-256.

REFERENCES

Jambro, Donald J., Introduction to Manufacturing, Albany, NY, Delmar Publishing Co., (1982).

Kazanas, et. al., Basic Manufacturing Processes, New York, McGraw-Hill Book Co., (1981).

Wright, R. Thomas, Processes of Manufacturing, South Holland, IL, Goodheart-Willcox Co., (1987).

MODULE: 2 : Manufacturing Materials and Processes

LENGTH: 10 DAYS Manufacturing CLUSTER

Science groups all materials into three categories: gas, liquid, and solid. Of these three categories, solid material is the most commonly used type in products. Solid material is often called "engineering material" in industry. This module is designed to introduce students to the types of solid industrial materials.

Three major points should be stressed by the instructional materials and activities. They are: the properties and characteristics of materials, material testing, and the proper selection of materials. The information presented here will provide a foundation for future processing modules.

The vast number of materials can be grouped under three basic materials (metals, polymers, ceramics). Combining two or more of these materials creates a fourth group named composites. Historically, there is a background to each of these groups, such as John Wesley Hyatt was Father of Plastics. Humans consistently try improving materials to improve our way of life.

Metals are crystalline in structure and made up of inorganic matter. The three most commonly used metals are iron-based alloys, aluminum alloys, and copper alloys.

Polymers are both natural (animal/vegetable proteins, starch, and cellulose) and synthetic (thermoplastics and thermosetting plastics). Polymers are made up of large chains of organic molecules. The single molecule is called a monomer. Plastics are changed by adding different elements into the chain. This process is called polymerization.

Ceramic materials are inorganic substances, metallic or nonmetallic in nature and crystalline in structure. There are four classes of ceramic materials. They are: clay-based materials (earthenware, china, and structural clay), refractories (able to withstand high temperatures), glasses (silica sand with other materials added), and inorganic cements.

Two or more materials which are bonded together by adhesion are called a composite. Composites can be natural such as wood (hard or soft), or it can be manufactured such as fiberglass.

All materials have different characteristics and properties (mechanical and physical). This wide variety in material has made it possible to produce many different products. Students need to know why materials behave in the ways they do. They also need to know how people change those behaviors. For example, two different metals mixed together to form an alloy.

Material processing is the conceptual flow of materials from raw material to finished goods. Many students do not understand the complexities of changing materials. There are three stages. They are: (1) obtaining natural resources, (2) producing industrial materials, and (3) making finished products.

There are three ways of obtaining natural resources:

1. mining—digging the material from the earth by means of a hole or tunnel
2. drilling—pumping material from the earth by means of a hole or tunnel
3. harvesting—cutting a mature, renewable resource from the land.

Primary processing is converting raw materials into industrial materials (stand stock). Thermal, mechanical, and chemical processing are the three major types of primary processing.

1. thermal uses the addition of heat to convert raw materials
2. mechanical uses cutting or crushing action to convert raw materials
3. chemical uses chemical reactions to refine materials.

Secondary processing converts industrial materials (standard stock) into finished goods. There are six secondary processes. The six are defined as follows:

1. Casting and molding—pouring or forcing liquid or plastic state material into a prepared mold. The material is allowed to become solid. Then it is removed from the mold.
2. Forming—using force to cause a material to permanently take a shape. A die, mold, or roll is used to shape the material. There is no change in the volume of the material.
3. Separating—converting material size and shape by removing excess material. The material is cut or sheared by these processes.
4. Conditioning—using heat, mechanical force, or chemical action to change the internal properties of a material.
5. Assembling—temporarily or permanently holding two or more parts together.
6. Finishing—protecting and/or adding beauty to the surface of a material.

Finished goods are classified into three groups. Consumer goods are products which are available to the public. Industrial goods are materials used specifically by industry to be further processed. Finally, military goods are materials or products for military purposes.

One of the goals of education is to provide responsible citizens for society. If that is true, then one byproduct of society, not to be left out of the discussion, is pollutants. It is estimated that 92 billion pounds of industrial waste is produced every year. Your students have some important decisions to make in the future. Provide information to help them.

Your students are the present and future consumers. They need to know the value of appropriate selection of materials. Describe how materials are sized and graded for sale. Stress the importance of choosing the right material and not wasting that material.

Many simple activities can be set up to illustrate material properties and processes. Laboratory centers with destructive and nondestructive testing and manufacturing processing activities will allow students to experiment with material and processing procedures. To allow small group participation, several activity centers should be set up.

OBJECTIVES

1. List and describe the types of engineering materials.
2. List and describe the basic properties of engineering materials.
3. Select engineering materials for specific applications.
4. Describe how materials are sized and graded for sale.
5. Conduct simple tests to compare selected properties of common engineering materials.
6. Differentiate between obtaining raw materials, primary processing, and secondary processing.
7. List and describe the three techniques used to obtain raw materials from the earth.
8. List and describe the three techniques used in primary processing.
9. List and define the six types of secondary processes.
10. Discuss the outputs of manufacturing.
11. Describe the types of raw materials.
12. Differentiate among a raw material, standard stock or industrial material, and finished products.
13. List and describe several standard stock materials.
14. Describe the production of selected industrial materials.
15. Investigate and analyze industrial materials on the ecological balance, the utilization and conservation of natural resources, and the recycling capabilities of industrial materials and products.
16. Transfer knowledge gained from other classes or learning situations, and apply that knowledge to the activities.
17. Exhibit good work habits, respect for, and cooperation with associates.
18. Identify career paths for a selected career field in materials and processing technology.

PRESENTING THE MODULE

DAY	ACTIVITY
0	Before you introduce this module: develop or update your daily lesson plans, generate handouts, collect examples, select media and materials necessary to support your instruction, and determine activities capable of supporting the module content. Read several teacher resources and the student textbook. Some suggested readings are: Exploring Manufacturing: pp. 21-60 Manufacturing (Fales): pp. 42-47 and 410-429 Manufacturing (Wright): pp. 28-29 Intro to Manufacturing: pp. 19-44 Material Processing: pp. 1-70 Basic Manufacturing Processes: pp. 48-92. Note: A bibliography is listed in the appendix. Also, keep current with other sources of information such as magazines, professional publications, professional meetings, and other local school systems. Develop meaningful activities and experiences which will support the concepts of this module. An activity should not be lengthy, but a variety of activities should be presented to the students. Prepare activity sheets to facilitate better learning. Obtain and/or prepare materials for selected classroom and laboratory activities. Remember, this is a curriculum guide. Some modifications will be necessary to meet your specific needs. Constantly, you should evaluate and update activities and instructional materials.
1	Discuss the different types or classifications of engineering materials (metals, polymers, ceramics, and composites). Explain and discuss material grading systems (i.e., lumber—FAS, Selects, Commons) and purchasing standard stock materials by units, weight, surface measure, and volume. Prepare and distribute engineering material kits to groups of two to four students. Kits should include a variety of materials. The students are to classify materials according to metals, polymer, ceramic, and composites. Use activity sheets to record results. Supervise the activity. Survey activity results.

CALENDAR

DAY	ACTIVITY
1	Discussion of material families and classifications of engineering materials. Daily activity also includes a student activity in which students are asked to classify a group of materials into the following four classifications: metallics, ceramics, polymers, and composites.
2	Discussion of material properties and characteristics. Properties and characteristics to be discussed include: mechanical characteristics and thermal, chemical, optical, and acoustical properties. Daily activity also includes student activity in which students are asked to classify their original group of material according to its characteristics and properties.
3	Discussion of destructive and nondestructive testing. Daily activity also includes a demonstration of selected tests. Students begin material testing activities.
4	Students should review testing procedures, gather testing specimens and equipment, and perform material testing laboratory activities.
5	Students should review testing procedures, gather testing specimens and equipment, and perform material testing laboratory activities.
6	Introduction to material processing including primary and secondary processing. Daily activity also includes student activity in which students categorize processes into primary and secondary classifications.
7	Discussion of renewable and exhaustible resources.
8	Discussion and laboratory activities focusing on the production of standard stock and materials.
9	Students should review laboratory procedures, gather necessary materials and equipment, and perform laboratory activities which reinforce the principle of changing industrial materials into standard stock.
10	Students should review laboratory procedures, gather necessary materials and equipment, and perform laboratory activities which reinforce the principle of changing industrial materials into standard stock.

DAY	ACTIVITY
	Read textbook assignment. Students should: 1. sort and organize materials in the engineering material kits according to the types of classifications. 2. record findings for the activity results. 3. report findings to the instructor and classmates about the activity.
2	Discuss the different properties of engineering materials, such as: **mechanical properties**—strength, elasticity, stiffness, plasticity, ductility, malleability, brittleness, hardness, wear resistance, toughness, fatigue **thermal properties**—melting and freezing point, thermal conductivity, thermal expansion **chemical properties**—electrical conductivity, electrical resistivity, permeability **optical properties**—opacity, color **accoustical properties**—absorb sound, transmit sound, reflect sound. Pass out engineering material kits to the students again. Have the students classify the materials according to properties. Supervise the activity. Survey activity results. Students should: 1. sort and organize material in the engineering material kit according to properties. 2. record findings for the activity results. 3. report findings to the instructor and classmates about the activity.

PRESENTING THE MODULE - Continued

DAY	ACTIVITY
3	Discuss the various ways of performing material testing. The two main categories are: **destructive testing**—tensile, compression, flexture, impact, and fatigue **nondestructive testing**—visual, radiographic, ultrasound, magnetic, and electrical. Demonstrate material testing activities and stress safety procedures. Here are some sample material treating activities sources: Exploring Manufacturing Guide: pp. 14-15 Material Processing Textbook Center for Industrial Technology Education at Ball State University. Hand out activity sheets and specimens. Start and supervise the laboratory activities. Students should: 1. Observe the demonstrations of specific material testing activities and: a. record the steps to complete the activities b. list all safety procedures. 2. Gather material specimens and activity sheets needed for the material test. 3. Start experimenting with the various types of testing activities. 4. Keep records of all findings and results.
4-5	Supervise and facilitate completion of laboratory activities. Students should: 1. Review material testing procedures and safety precaution 2. Continue experimenting with various types of testing activities 3. Record and compare findings.

DAY	ACTIVITY
6	Discuss the process of changing materials from a raw material into a finished product. This process is called material processing. There are two categories of material processing. They are: 1. **primary processing**—changing raw materials into industrial material (standard stock). 2. **secondary processing**—changing industrial materials into finished products. Discuss in general (at this point): 1. three ways of obtaining raw materials (mining, drilling, and harvesting) 2. three primary processes (chemical, thermal, and mechanical) 3. the six secondary processes (casting/molding, forming, separating, conditioning, assembly, and finishing) 4. products waste and scrap. Note: you could add a recycling project here (extra credit). Hand out activity sheets which have students identifying primary or secondary processes with photos. After identifying primary or secondary, they must identify the specific process. Ex. Photo 1 Secondary - Assembly Photo 4 Primary - Chemical Manufacturing (Wright) Lab Manual: pp. 7-10 Supervise activity and collect papers.
7	Discuss the difference between renewable and exhaustible resources. Explain the three-step process of obtaining resources. 1. **locating resources**—aerial mapping or seismic studies 2. **gathering resources**—mining, drilling, harvesting 3. **transporting resources**—trucks, ships, pipelines, etc. Show a film dealing with steel making, lumber manufacture, plastic production, etc. Hand out a film review sheet, if possible.

PRESENTING THE MODULE - Continued

DAY	ACTIVITY
8	Discuss the production of industrial materials. Discuss "What are standard stock materials?" Give examples in lumber, metal, and plastics. Discuss the production of steel, lumber, and plastics. Develop a laboratory activity which allows students to make industrial materials. Some could be further processed into a finished product. Example activities: From the People Create Technology Activity Manual: 1. Act. 9 "Particle Board and Lumber Mold" needed for Act. 10. 2. Act. 10 "Using Resources to Create Products: Abrasive Stone." 3. Act. 13 "Combining Raw Materials: Making Glass." From Exploring Technology Guide: 1. Act. 7A "Making Plywood." 2. Act. 7B "Tic-Tac-Toe Game from plywood." Demonstrate the laboratory activities and stress safety procedures. Hand out lab materials and activity sheets. Supervise students as they complete laboratory activity. Students should: 1. change laboratory setting if necessary 2. if necessary, demonstrate the activity of changing the industrial materials into a finished product.
9-10	Issue materials to the students. Supervise students as they complete their laboratory activity (finished products). Review major concepts in this module and relate discussion to all activities.

APPENDIX

Instructional Materials:

1. Teacher developed and/or commercially available transparencies/slides/16mm or video films/filmstrips/charts, etc., describing primary and secondary processing, types of industrial materials, and grading systems. Some sample sources are:

   a. Modern Talking Picture Service

   b. Manufacturing Forum

   c. DCA Educational Products, Inc.

   d. Creative Learning Systems, Inc.

2. Developed or updated instructor's daily lesson plans.

3. Course syllabus.

4. Handouts and activity sheets on:

   a. primary processing activities

   b. any other helpful information

   c. engineering materials

   d. activity sheets for the engineering material kits

   e. activity sheets to go with material testing activities.

Special equipment and supplies:

1. five pieces of veneer for each student to make plywood

2. clamps or vises to make plywood

3. jig and fixtures to change plywood into a game

4. wood, nails, and dowel rods to make molds for People Create Technology, Activity #9

5. powder clay and flint, and silicon carbide for People Create Technology, Activity #10

6. small kiln for People Create Technology, Activity #10

7. triple beam balance for Activity #10 and #13

8. borax, boric acid, and cobalt oxide (for making glass) for People Create Technology, Activity #13

9. clay crucible and kiln for Activity #13.

10. Prepare kits of engineering materials. Use various types of materials:

    a. metals, such as steel, copper, and aluminum

    b. polymers, including acrylics—plexiglass, polyethelene bags, films, snap-on lids; nylon—combs, stockings

    c. composites, including hardwoods, softwoods, concrete, and fiberglass.

11. Develop and make several material testers, such as:

    a. Corrosion Test (Teacher's Manual for Exp. Manu., p. 14)

    b. Linear Expansion of Metal Test (Teacher's Manual, p. 14)

    c. Strength Test (Teacher's Manual, p. 15)

    d. Thermal Conductivity (Material Processing Textbook, p. 3)

    e. Compression Strength Test (Material Processing Text, p. 10)

    f. Tension Test (Material Processing Text, p. 11)

    g. Impact Strength Test (Material Processing Text, pp. 13-14)

    h. Hardness Test (Center for Industrial Technology Education)

    i. Mechanical Fastener Test (CITE)

    j. Metallic Wire Tensile Test (CITE)

    k. Natural Polymer Cleavage Test (CITE)

    l. Natural Polymer Shear Test (CITE)

m. Natural Polymer Tensile Test (CITE).

Safety equipment is necessary for observing and performing activities.

Textbook Resources:

Fales, James, et. al., Manufacturing, A Basic Text for Industrial Arts, (1980), McKnight & McKnight Publishing Co., Bloomington, IL.

Jambro, Donald J., Introduction to Manufacturing, (1982), Delmar Publishing, Inc., Albany, NY.

Kazanas, et. al., Basic Manufacturing Processes, (1981), Gregg Divn., McGraw-Hill Book Co., New York.

Thode, Bradley R., Material Processing, (1982), Delmar Publishing, Inc., Albany, NY.

Wright, R. Thomas, Exploring Manufacturing, (1985), Goodheart-Willcox Co., Inc., South Holland, IL.

Wright, R. Thomas, Manufacturing: Material Processing, Management, Career, (1976), Goodheart-Willcox Co., Inc., South Holland, IL.

Publications:

Manufacturing Forum, Department of Industry and Technology, Ball State University, Muncie, IN 47306.

The Technology Teacher, 1919 Association Dr., Reston, VA 22091.

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TEXTBOOKS

Fales, James, et. al., Manufacturing: A Basic Text for Industrial Arts, Peoria, IL, Bennett & McKnight Publishing Co., 1983 (Textbook and Teacher's Guide): pp. 42-47 & 410-429.

Wright, R. Thomas, Exploring Manufacturing, South Holland, IL, Goodheart-Willcox Co., 1985 (Textbook, Teacher's Guide, Student Manual, and Activity Sheets): pp. 21-60.

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Jambro, Donald J., Introduction to Manufacturing, Albany, NY, Delmar Publishing Co., 1982.

Kazanas, et. al., Basic Manufacturing Processes, New York, McGraw Hill Book Co., 1981.

Wright, R. Thomas, Processes of Manufacturing, South Holland, IL, Goodheart-Willcox Co., 1987.

MODULE: 3 : Parts Manufacturing Processes

LENGTH: 15 DAYS Manufacturing CLUSTER

The next two modules deal with the subject of secondary processing. By definition, secondary processes change industrial materials into finished goods. There are six secondary processes. They are casting/molding, forming, separating, conditioning, assembly, and finishing. This module will focus on casting/molding, forming and separating processes.

The casting and molding activities are designed to present the conceptual structure for this process, and provide students with an opportunity to complete selected casting and molding activities.

Casting and molding is the manufacturing process in which a material is made liquid, then introduced into a prepared mold of proper design where the material is caused to solidify before being extracted.

All casting and molding processes involve a five-step sequence:

1. a permanent or expandable mold is prepared
2. the material is prepared by melting, dissolving/suspending, or adding agents to liquids
3. the material is introduced into the cavity using gravity (casting) or other forces (molding), i.e., vacuum, pressure, or explosion
4. the material is caused to solidify by cooling/freezing, drying, or chemical action
5. the product is extracted by either destroying the mold, or, opening the mold and extracting or ejecting the part.

Forming processes change the size and shape, but not the material volume, of a part by the application of a force above the yield point and below the fracture point. There are three common factors to all forming processes. These factors are:

1. material preparation examples would be hot and cold
2. the shaping device is used
3. there is a method of applying a force; most common techniques are hammers, presses, draw bench, and rolling mills.

Separating processes include processes which remove excess material to change the desired size, shape, and/or surface finish of a part.

There are three major groups:

1. **machining**—removing the excess material from a part in the form of chips or particles
2. **shearing**—fracturing away the excess material using opposing edges
3. **nontraditional**—processes not using the conventional wedge cutting tool.

Every separating process has three essential elements:

1. a tool or cutting element (single or multiple point tools, nontraditional, and flame cutting) is always used
2. there is motion (cutting and/or feed) between the work and the cutting element
3. the tool and the work are clamped or held (i.e., centers, chucks, or clamps) in position.

Selected separation processes include:

Machining:

1. **turning machines**—rotate the work against a tool
2. **milling and sawing machines**—tool rotates as the work moves toward the cutter
3. **drilling machines**—rotate a pointed tool to create a hole
4. **planning and shaping machines**—a single point cutter is used to remove a continuous chip
5. **grinding and abrasive machines**—randomly arranges particles bonded together which rotates to remove small particles from the base material.

Shearing:

1. **blanking**
2. **piercing**
3. **notching.**

Nontraditional:

1. **laser**

2. **electrical discharge machine**

3. **high pressure water.**

Laboratory activities reinforce concepts learned in the classroom. When developing activities for this module, use a variety of materials (metals, ceramics, plastics, etc.). Use small group participation in the laboratory. Product used in this module will be further processed in the other modules.

OBJECTIVES

Upon completing this learning module, each student should be able to:

1. Define and describe the secondary processes of casting, molding, forming, and separating.
2. List and describe the basic principles of casting, molding, forming, and separating.
3. Identify selected consumer and industrial goods and products which are manufactured using casting, molding, forming, and separating processes.
4. Transfer knowledge gained from other classes or learning situations and apply that knowledge to the activities.
5. Gain skills when using tools and/or machinery related to the activities.
6. Exhibit good work habits, respect for and cooperation with associates.
7. Identify career paths for a selected career field in materials and processes technology.

CALENDAR

DAY	ACTIVITY
1	Review secondary processes and introduce casting and molding processes and their applicable principles. Demonstrate a casting and/or molding process to reinforce the applicable principles.
2	Continue the discussion of secondary processes. Focus on molding processes and their applicable principles. Demonstrate a molding process to reinforce the applicable principles.
3-5	Students should review laboratory procedures, gather necessary materials and equipment, and perform laboratory activities which reinforce the principles of casting and molding processes.
6	Continue the discussion of secondary processes. Discuss forming processes and their applicable principles. Demonstrate a forming process to reinforce the applicable principles.
7-9	Students should review laboratory procedures, gather necessary materials and equipment, and perform laboratory activities which reinforce the principles of forming processes.
10	Continue the discussion of secondary processes. Discuss separation processes and their applicable principles. Demonstrate separation processes to reinforce the applicable principles.
11-14	Continue demonstrations of separation processes. Students should review laboratory procedures, gather necessary materials and equipment, and perform laboratory activities which reinforce the principles of separation processes.
15	Review and discuss the concepts and processes utilized and discussed during this module.

PRESENTING THE MODULE

DAY	ACTIVITY
0	Before you introduce this module: develop or update your daily lesson plans, generate handouts, collect examples, select media and materials necessary to support your instruction, and determine activities capable of supporting the module content. Read several teacher resources and the student textbook. Some suggested readings are: Basic Manufacturing Processes: pp. 93-253 Exploring Manufacturing: pp. 69-100 Intro to Manufacturing: pp. 55-118 Manufacturing (Fales): pp. 47-49; 369-387; 308-337 Manufacturing (Wright): pp. 35-64 Material Processing: pp. 87-132. Also, keep current with other sources of information, such as magazines, professional publications, professional meetings, and other local school systems. Develop meaningful activities and experiences which will support the concepts of this module. An activity should not be lengthy, but a variety of activities should be presented to the students. Prepare activity sheets to facilitate better learning. Obtain and/or prepare materials for selected classroom and laboratory activities. Remember, this is a curriculum guide. Some modifications will be necessary to meet your specific needs. You should evaluate and update activities and instructional materials constantly.
1	Prepare a daily lesson plan which will review manufacturing processes, introduce the secondary processes of casting and molding, their applicable principles, and present a demonstration of a casting and/or molding process to reinforce those principles. Major points to be identified during the lesson include: 1. Manufacturing processes convert the form of materials to produce industrial and consumer products. It should be pointed out that these products are produced at one location for use or consumption at another. 2. During discussion the teacher can point out that the clothes the students are wearing, the chairs they are sitting in, the doors to the room, the transportation vehicle that brought them to school, possibly the food they had for breakfast or lunch, etc. were all manufactured.

DAY — ACTIVITY

3. When presenting the principles and/or concepts of manufacturing processes (material conversion), it is often helpful to look at the system(s) involved in the conversion process. When analyzing these systems, the teacher should point out that each system consists of an input, process, and output.

4. The inputs of a material conversion system include materials, energy, and information. The process utilizes these inputs and converts the materials by changing their shape, composition, and/or combinations.

5. Have the students identify several processes and then examine their inputs/processes/outputs.

6. Manufacturing processes are used to convert engineering materials into industrial and consumer products. These processes, often referred to as secondary operations, produce parts, subassemblies, or final assemblies (products).

7. Introduce secondary casting processes and identify several industrial examples. In a discussion of the identified processes the teacher should describe how the definition reflects the five casting principles of:

   a. preparing the material

   b. preparing the cavity (mold)

   c. introducing the material

   d. solidifying the material

   e. extracting the material.

   The identified processes should also be expanded upon by describing the purposes, products, and principles of each.

8. When demonstrating identified casting processes, it is important that the casting principles be emphasized because of their ability to transfer and support future learning.

9. Discuss these principles with the students and use them to describe other casting processes or laboratory activities.

2 Prepare a daily lesson plan that will introduce molding processes, their applicable principles, sample products, and present a demonstration of molding processes to reinforce these principles.

DAY | ACTIVITY

Major points to be identified during the lesson include:

1. Manufacturing processes convert the form of materials to produce industrial and consumer products. It should be pointed out that these products are produced at one location for use or consumption at another.

2. Have the students identify products which are manufactured using molding processes.

3. Although, casting and molding processes both have the same material conversion principles, the state of the material during shaping (plastic not liquid) may justify a separate definition and a description of the processes unique to molding processes.

4. Identify and describe five molding processes which are commonly, but not exclusively, used in the plastics industry. When discussing and describing these processes: injection molding, blow molding, extrusion, compression molding, and rotational molding, the teacher should emphasize how the material is prepared, the type and characteristics of the mold and cavity, how the material is introduced into the cavity, the technique used to solidify the material, and process used to extract part of the product.

5. Demonstrate selected molding laboratory activities.

6. When demonstrating casting/molding processes it is important that the principles be emphasized because of their ability to transfer and support future learning.

7. Discuss these principles with the students and use them to describe other molding processes or laboratory activities.

Remember to develop activity description and analysis sheets, picture-pack manuals, or any other type or instructional material to help students with the activities and/or concepts. Parke's projects and the table top foundry have manuals included.

Some sample casting and molding activities to be considered are:

1. casting a sand candle

DAY	ACTIVITY

2. petrobond sand casting a metal object use a "table-top" foundry unit. (Each unit has supplies for four students.) Petrobond must be ordered separately.

3. casting a candle using a permanent plastic or metal mold; Parke's candleholder project has a section where a candle is cast using a metal mold.

4. injection molder with molds. This is a mold which makes a handle for a small phillips or standard bladed screwdriver.

5. rotational molder with molds

6. dip casting coin purses

7. slush casting football tees or door stops

8. slip casting a ceramic object

9. casting a plaster object

10. Parke's screwdriver project uses a handle mold to cast a water extended polyester handle.

Product list here might be used in combination with other modules. Examples: You must first make the screwdriver blade (Parke's) using drop forging (forming), grinding (separation), etc.,...before casting the handle. (NOTE: Do not use the same activities which will be used in the Manufacturing Materials and Processes Course)

Stress all safety precautions.

Have the students fill out an activity analysis sheet for at least one of the casting/molding laboratory activities that they completed.

3-5 Review or demonstrate casting/molding activities, stressing safety at all times.

Hand out materials and activity sheets.

Supervise laboratory activities.

Finish and collect all casting and molding activities.

DAY	ACTIVITY
6	Prepare a daily lesson plan which will introduce the forming processes, their applicable principles, sample products, and present a demonstration of forming processes to reinforce these principles.

Major points to be identified during the lesson include:

1. Manufacturing processes convert the form of materials to produce industrial and consumer products. It should be pointed out that these products are produced at one location for use or consumption at another.

2. Have the students identify products which are manufactured using forming processes.

3. Similar to casting and molding, forming processes change the shape of a material, but not its volume (contour change). However, forming processes depend upon a material's ductility to change the shape of the material by the application of force between the material's yield and fracture points.

4. During a discussion of forming principles, use examples to introduce each principle and the identified variables of each. These principles include:

   a. Material preparation includes hot, cold, and other techniques. "Hot" includes all forming processes done at elevated temperatures. "Cold" includes all forming processes done at room temperature. "Other" includes techniques of material preparation such as surface coatings for lubrication or release purposes.

   b. Shaping or contouring devices include open, closed, mated, and one piece dies, and roll forming. "Open Die" forming processes are the simplest form of a shaping device. During discussion, provide examples of forming processes, such as Smith Forging, that use open, basically flat, die surfaces.

5. Die sets include "closed" and "mated" dies.

6. Discussion of these contouring devices should focus on examples of parts or products that are produced using drop and press forging.

   "One piece" shaping devices typically draw a material over the die. Typical parts produced using this process include pots and pans, automotive body parts, metal spinning, and thermoforming. Extrusion processes also use a one piece die. However, instead

DAY	ACTIVITY

of drawing the material over the die, the material is pushed through the one piece die.

"Roll" forming processes convert materials by rolling the material between rotating smooth or shaped rollers. Pipe, "I" beam, and curved members, such as storage tanks, are all manufactured by rolling.

There are two basic types of "Contouring Force" in a forming process. One is dynamic (hammering) and the other is static (pressing). In both, the material is shaped by applying force to the material between the materials yield and fracture points.

7. Demonstrate selected forming laboratory activities.

8. When demonstrating forming processes, it is important that the principles be emphasized because of their ability to transfer and support future learning.

9. Discuss these principles with the students and use them to describe other forming processes or laboratory activities.

7-9 Develop and demonstrate forming activities.

Some sample forming activities are as follows:

1. Parke's screwdriver project: drop forging blade

2. vacuum or thermoformer

3. Parke's candle holder project: explosion form copper part and metal spinning aluminum part

4. hydro forming Parke's candle holder

5. small sheet metal product

6. wrought iron bending, roll forming.

These are some ideas. Use your ideas to create new and better ideas. Some of these products carry over to other modules or activities.

Stress all safety precautions.

Hand out materials and activity sheets.

DAY	ACTIVITY
	Supervise all laboratory activities. Finish and collect all forming products. (NOTE: Do not use the same activities that will be used in the Manufacturing Materials and Processes course.) Have the students fill out an activity analysis sheet for at least one of the forming laboratory activities that they have completed.
10	Prepare a daily lesson plan that will introduce the separation processes, their applicable principles, sample products, and present a demonstration of separation processes to reinforce these principles. Major points to be identified during the lesson include: 1. Manufacturing processes convert the form of materials to produce industrial and consumer products. It should be pointed out that these products are produced at one location for use or consumption at another. 2. Have the students identify products which are manufactured using separation processes. 3. Introduce and describe separation processes. 4. Describe the five principles of a separation process. These principles include the type(s) of separation process, cutting element, coolant, cutting element or material support, and cutting element or material motion. During the discussion of the separation principles, separation processes should be identified and used to introduce and provide examples of each principle and the identified variable(s) of each. a. Types of separation include shearing (sheet metal shear, scissors, knife), machining (milling, sawing, drilling, abrading), and non-traditional (etching, laser, EDM, electron beam). Closely related to, and associated with the types of separation processes, is the description of the cutting elements: single point, multiple point, and other medium. b. During the discussion of the separation principles, the importance of the coolant and cutting element and/or material support should not be overlooked. In many processes the coolant may be as simple as the atmosphere surrounding the tool and material being separated, or, as

DAY	ACTIVITY
	sophisticated as a filtered recirculating liquid coolant system. Cutting element support (chuck, collet, nut, pin) and material support (mechanical and pneumatic clamps, hold downs, magnetic chucks) are important principles to be considered when planning and developing an understanding of a separation process.
	c. Cutting element or material motions include inline reciprocating, and circular motions.
	5. Demonstrate selected separation laboratory activities.
	6. When demonstrating separation processes, it is important that the principles be emphasized because of their ability to transfer and support future learning.
	7. Discuss these principles with the students and use them to describe other separation processes or laboratory activities.
11-14	Demonstrate the basic machines they will be using in the activities. Examples: drill press, band saw, etc.
	Discuss and stress proper procedures and safety.
	Demonstrate additional types of separating practices when needed.
	Hand out activity sheets.
	Supervise laboratory activities.
	Collect products.
	During all demonstrations and laboratory activities, students should:
	1. observe demonstrations and record procedural and safety information
	2. participate in laboratory activities
	3. complete an analysis sheet
	4. follow all safety procedures.
15	Review and discuss the concepts and processes utilized and discussed during the module.

APPENDIX

Instructional Materials:

1. Teacher-developed and/or commercially available transparencies/slides/16 mm or video films/filmstrips/charts, describing separating and its essentials. Some sample sources are:

   a. Modern Talking Picture Service

   b. Manufacturing Forum

   c. DCA Educational Products, Inc.

   d. Creative Learning Systems, Inc.

2. Developed or updated instructor's daily lesson plans.

3. Course syllabus.

4. Handouts and activity sheets on:

   a. describing the process of separation

   b. description and analysis sheets for separating activities

   c. describing the process of forming

   d. descriptions and analyzing forms for forming activities

   e. describing casting and molding

   f. describing and analyzing casting and molding activities.

Special Equipment and Supplies:

1. thermoformer (vacuum former)
2. hydraulic press
3. explosion former (Parke's)*
4. hydroformer (Parke's)*
5. drop forge (Parke's)*
6. purple load Ram-Set Charges
7. oxygen and acetylene torch

8. metal spinning fixture (Parke's)* for wood or metal lathe
9. electric hot plate
10. metal (Parke's* Adventure Products) or plastic permanent candle molds
11. injection molder and molds
12. rotational molder and molds
13. parke's* screwdriver mold for casting water extended polyester
14. tabletop foundry with petrobond sand
15. slip casting molds
16. plaster casting molds
17. sand for casting sand candles (nonpermanent mold)
18. molds for making paper weights using clear acrylic resins
19. blanking die for Parke's* product
20. safety equipment necessary for observing and performing activities.

* Nelson L. Parke
805 South Devonshire
Springfield, MO 65802

Textbook Resources:

Fales, James, et. al., (1980), Manufacturing, A Basic Text for Industrial Arts, Bloomington, IL, McKnight & McKnight Publishing Co.

Jambro, Donald J., (1982), Introduction to Manufacturing, Albany, NY, Delmar Publishing, Inc.

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MODULE: 4 : Parts and Product Completion Processes

LENGTH: 9 DAYS Manufacturing CLUSTER

Module #3 focused on the secondary processes used to manufacture parts (casting, molding, forming, and assembly). This module will focus on the secondary processes used to complete parts and products (conditioning, assembly, and finishing).

Conditioning processes change the mechanical or physical properties of a material. These changes are caused by a change of the internal structure of a material.

There are three main reasons why a manufacturing industry would change material characteristics. They are to improve machining and forming capabilities, remove internal stress, and impart desired properties of a part.

Assembly processes are used to semi or permanently join (assemble) two or more materials or parts together. This module introduces assembly processes and identifies four basic techniques to assemble materials.

1. mixing
2. weaving
3. magnetic fields
4. joining.

Discussion should focus on each of the techniques and the three joining methods:

1. adhesion
2. cohesion
3. mechanical.

Finishing is a surface treatment which protects and/or decorates a material. Our environment has put great demands on improving and perfecting finishes. Acid rain, temperature change, moisture content, and insects tend to shorten the life expectancy of many of our materials.

We also live in a world of fads and bright colors. The consumer demands not only beauty of the finish in a product, but quality of the application. Finishing involves three basic steps. First, picking the correct type of finishing material; second, preparing the part to accept the finish; finally, applying the finish.

INTRODUCTION - Continued

Converted finishes and surface coatings are the two major classes of finishes. Converted finishes change the molecular structure of the surface to make a protective layer. Examples would be anodizing, oxidizing, and phosphating. Surface coatings, when applied, form a protective layer over the part. Examples of these are organic coatings (paints or lacquers) and inorganic coatings (galvanizing).

Industry has two basic methods of preparing the parts for finish. Mechanical cleaning requires abrasive, wire brushes, or metal shots to remove dirt and roughness. Chemical cleaning uses liquids or vapors to remove dirt and grease.

Brushing, rolling, spraying, and dipping are all methods of applying finishes to parts. To choose the right method involves evaluating the physical area and the type of finishing material.

Include many of these techniques in the laboratory activities. Remember concepts learned in the classroom should be applied to the student's products.

OBJECTIVES

Upon completing this learning module, each student should be able to:

1. Define and describe the secondary processes of conditioning, assembling, and finishing.
2. List and describe the basic principles of conditioning, assembling, and finishing processes.
3. Identify selected consumer and industrial goods and products that are manufactured using conditioning, assembling, and finishing processes.
4. Product products using selected conditioning, assembling, and finishing processes.
5. Transfer knowledge gained from other classes or learning situations and apply that knowledge to the activities.
6. Gain skills when using tools and/or machinery related to the activities.
7. Exhibit good work habits, respect for, and cooperation with associates.
8. Identify career paths for a selected career field in materials and processes technology.

CALENDAR

DAY	ACTIVITY
1	Review secondary processes, introduce conditioning processes, and their applicable principles. Demonstrate conditioning processes to reinforce the applicable principles.
2-3	Continue demonstrations of conditioning processes. Students should review laboratory procedures, gather necessary materials and equipment, and perform laboratory activities which reinforce the principles of conditioning processes.
4	Continue the discussion of secondary processes. Discuss assembly processes and their applicable principles. Demonstrate assembly processes to reinforce the applicable principles.
5-6	Continue demonstrations of assembly processes. Students should review laboratory procedures, gather necessary materials and equipment, and perform laboratory activities which reinforce the principles of assembly processes.
7	Continue the discussion of secondary processes. Discuss finishing processes and their applicable principles. Demonstrate finishing processes to reinforce the applicable principles.
8	Students should review laboratory procedures, gather necessary materials and equipment, and perform laboratory activities which reinforce the principles of finishing processes.
9	Review and discuss the concepts and processes utilized and discussed during this module.

PRESENTING THE MODULE

DAY	ACTIVITY
0	Before you introduce this module, develop or update your daily lesson plans, generate handouts, collect examples, select media and materials necessary to support your instruction, and determine activities capable of supporting the module content.

Read several teacher resources and the student textbook. Some suggested readings are:

Basic Manufacturing Processes: pp. 254-360
Exploring Manufacturing: pp. 101-126
Manufacturing (Fales): pp. 48-51, 388-397, 334-357
Manufacturing (Wright): pp. 65-86

Note: A bibliography is listed in the appendix.

Also, keep current with other sources of information such as magazines, professional publications, professional meetings, and other local school systems.

Develop meaningful activities and experiences which will support the concepts of this module. An activity should be lengthy, but a variety of activities should be presented to the students. Prepare activity sheets to facilitate better learning.

Obtain and/or prepare materials for selected classroom and laboratory activities.

Remember, this is a curriculum guide. Some modifications will be necessary to meet your specific needs. You should evaluate and update activities and instructional materials constantly.

1 Prepare a daily lesson plan which will introduce the conditioning processes, their applicable principles, sample products, and present a demonstration of conditioning processes to reinforce these principles.

Major points to be identified during the lesson include the following: manufacturing processes convert the form of materials to produce industrial and consumer products. It should be pointed out that these products are produced at one location for use or consumption at another.

Discussion of conditioning principles should focus on:

1. the desired material characteristics or properties
2. material chemical, molecular, or crystal structure to be converted

DAY	ACTIVITY

3. conditioning material conversion process utilized

4. material characteristics or properties obtained.

During discussion, examples, such as heat treating, firing, polymerization, beaning, and magnetizing, should be used, as well as the appropriate principles used to describe and provide examples or conditioning processes.

Demonstrate several types of conditioning activities. Parts and products produced in previous modules should be conditioned in this module.

Some examples are:

1. Parke's Screwdriver--hardening of the blade, tempering of the blade, adding the catalyst to the water to extend polyester resin

2. bisque firing a slip cast product

3. chemical reaction during the setting of plaster

4. heating of the plastic during rotational molding, injection molding, and vacuum forming

5. work hardening of aluminum during spinning (Parke's candle holder project).

Discuss proper procedures and safety.

Have the students identify products that are manufactured using conditioning processes.

Note: Do not use the same activities that will be used in the Manufacturing Materials and Processes course.

2-3 Review or demonstrate conditioning practices.

Stress safety procedures.

Hand out activity sheets and laboratory materials.

Supervise all laboratory activities.

Collect all conditioned products and analysis sheets.

DAY	ACTIVITY
4	Prepare a daily lesson plan that will introduce assembly processes, their applicable principles, sample products, and present a demonstration of assembly processes to reinforce these principles.

Major points to be identified during the lesson include:

1. Manufacturing processes convert the form of materials to produce industrial and consumer products. It should be pointed out that these products are produced at one location for use or consumption at another.

2. Have the students identify products which are manufactured using assembly processes.

3. Introduce and describe assembly processes. Discuss how assembly processes are used to semi or permanently join (assemble) two or more materials of parts together. Identify the four basic techniques to assemble materials—mixing, weaving, magnetic fields, and joining. Discussion should focus on each of the techniques and the three joining methods—adhesion, cohesion, and mechanical.

4. Have students identify processes that are representative of each technique.

5. Discussion of assembly processes should also include a discussion of co-curing processes. Co-curing is used to add a property or characteristic to a base material(s) by permanently bonding a secondary material to it. Examples of co-cured materials include: steel belting in automobile tires, glass fiber in fiberglass, and reinforcing rods in concrete. It should be pointed out that there is no fusion between that base and secondary materials. The secondary material is cured in the base material.

Demonstrate assembling practices and techniques with emphasis on safety.

Just like the other modules, products in this module may have been started in other modules. Some examples are:

1. Pop riveting—candle holder pieces together.

2. Assemble the barbecue spatula. Exploring Manufacturing activity on p. 26 (Teacher's Guide); uses screws and pop rivets.

DAY	ACTIVITY
	3. Assemble the ecology box key holder. Exploring Manufacturing activity on p. 27 (Teacher's Guide). Uses upholstery tacks.
	4. A small sheet metal tray which uses spot welding and soldering or pop rivets.
	5. Any products you can design using various forms of assembly. Products do not need to be large in size.
5-6	Select activities that utilize a variety of materials and processes.
	Review or demonstrate assembly practices and safety.
	Hand out laboratory material and/or activity analysis sheets.
	Assist and supervise laboratory activities.
	Collect products and analysis sheets.
7	Prepare a daily lesson plan that will introduce finishing processes, their applicable principles, sample products, and present a demonstration of finishing processes to reinforce these principles.
	Major points to be identified during the lesson include:
	1. Manufacturing processes convert the form of materials to produce industrial and consumer products. It should be pointed out that these products are produced at one location for use or consumption at another.
	2. Have the students identify products that are manufactured using finishing processes.
	3. Introduce and describe finishing processes. Discuss how finishing processes are used to protect, decorate, and/or change the function of a material by coating or converting the material's surface. (Note: This definition not only includes the common purposes of "protect and decorate," but also includes a newly recognized purpose of "function." As material conversion processes become more sophisticated, it is necessary to change the function of a materials surface, such as making a wood surface a conductor prior to electrostatic spraying. Thus we find that finishes are applied to a material not just for the purpose of protecting of decorating, but to change a material property or characteristic.)

DAY ACTIVITY

4. Discussion of finishing principles should focus on:

   a. how finishing materials are selected and the two major techniques of finishing (coating and conversion)

   b. how the materials are prepared for finishing (mechanical and chemical)

   c. how finishing materials are applied (spraying, dipping, plating, rolling, brushing, and pouring).

   During discussion, examples of each principle should be provided.

List and explain the basic steps involving finishing.

1. Picking a finishing material.

   a. converted finishes—anodizing, oxidizing, phosphating

   b. surface coatings—organic (paints and lacquer), Inorganic (i.e., galvanizing).

2. Preparing the part to accept the finishing.

   a. mechanical cleaning (i.e., abrasives)

   b. chemical cleaning (i.e., liquid or vapor).

3. Applying the finish.

   a. applying conversion finishes (i.e., oxide coating)

   b. aaplying surface coatings--brushing, rolling, spraying, dipping, and electroplating.

Demonstrate several types of finishing practices. Here are some examples:

1. Have students bring in a pair of pliers, or some other type of metal handled tool, which can be dipped in a plastisol to coat the handles.

2. Apply a coating of jellied stain to Parke's screwdriver.

3. Stain a wood product.

PRESENTING THE MODULE - Continued

DAY	ACTIVITY
	4. Prime and finish coat a metal product.
	5. Glaze a ceramic product.
	6. Any other product you can develop..
	Stress safety procedures.
8	Review and demonstrate finishing practices and techniques. Stress safety procedures.
	Hand out laboratory materials and analysis sheets.
	Assist students and supervise laboratory activities.
	Collect products and analysis sheets at the end of the third day.
	During all demonstrations and laboratory activities students should:
	1. Observe demonstrations and record procedural and safety information.
	2. Complete activities and analysis sheets.
9	Review and discuss the concepts and processes utilized and discussed during this module.

APPENDIX

Instructional Materials:

1. Teacher developed and/or commercially available transparencies/slides/16 mm or video films/filmstrips/charts, describing the process of finishing and basic steps involved in all finishing practices. Some sample sources include:

   a. Modern Talking Picture Service

   b. Manufacturing Forum

   c. DCA Educational Products, Inc.

   d. Creative Learning Systems, Inc.

2. Developed or updated instructor's daily lesson plans.

3. Course syllabus.

4. Handouts and activity sheets on:

   a. describing the process of finishing

   b. descriptions and analysis sheets for the activities

   c. describing the process of conditioning

   d. descriptions and analysis sheet for the activities

   e. describing the process of assembly

   f. descriptions and analysis forms for the activities.

Special Equipment and Supplies:

1. small oven for tempering

2. oxygen and acetylene torch

3. a small drill stand for a 3/8" electric hand drill, aids in mixing water extended polyester

4. safety equipment necessary for observing and performing activities.

Textbook Resources:

Fales, James, et.al., Manufacturing, A Basic Text for Industrial Arts, McKnight & McKnight Publishing Co., Bloomington, IL, (1980).

Jambro, Donald J., Introduction to Manufacturing, Delmar Publishing, Inc., Albany, NY, (1982).

Kazanas, et.al., Basic Manufacturing Processes, Gregg Division/McGraw-Hill Book Co., New York, (1981).

Thode, Bradley R., Material Processing, Delmar Publishers, Inc., Albany, NY, (1982).

Wright, R. Thomas, Exploring Manufacturing, Goodheart-Willcox Co., Inc., South Holland, IL, (1985).

Wright, R. Thomas, Manufacturing: Material Processing, Management, Career, Goodheart-Willcox Co., Inc., South Holland, IL, (1985).

Publications:

Manufacturing Forum, Department of Industry and Technology, Ball State University, Muncie, IN 47306.

The Technology Teacher, 1919 Association Drive, Reston, VA 22091.

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TEXTBOOKS

Fales, James, et.al., Manufacturing: A Basic Text for Industrial Arts, Bennett & McKnight Publishing Co., Peoria, IL, (1980), (Textbook and Teacher's Guide), pp. 48-51; 334-357; 388-397.

Wright, R. Thomas, Exploring Manufacturing, Goodheart-Willcox Co., South Holland, IL, (1985), (Textbook, Teacher's Guide, Student Manual, and Activity Sheets), pp. 101-126.

REFERENCES

Jambro, Donald J., Introduction to Manufacturing, Delmar Publishing Co., Albany, NY, (1982).

Kazanas, et.al., Basic Manufacturing Processes, McGraw Hill Book Co., New York, (1981).

Wright, R. Thomas, Processes of Manufacturing, Goodheart-Willcox Co., South Holland, IL., (1987).

MODULE: 5 : Organizing, Financing, and Managing an Enterprise

LENGTH: 5 DAYS Manufacturing CLUSTER

A successful manufacturing enterprise must be able to maintain two types of processing which are material processing and management technology. Neither one can operate efficiently without the other. Management coordinates all the inputs (people, machines, materials, money, methods, and market) of a manufacturing system. The main goal of an enterprise is profit. The better material and management techniques mean better profit.

Management has four functions to perform. They are as follows:

1. **planning**—setting goals and courses of action to be followed.
2. **organizing**—dividing task into jobs and establishing lines of authority.
3. **directing**—assigning employees to jobs and encouraging them to complete their work efficiently.
4. **Controlling**—comparing results of employees' work with company plan.

If those four functions sound familiar, they should. Teachers are managers. Everyday, we perform these functions with our school systems and students. Levels of authority are also very familiar to organizations. There have to be lines of communications, but only managers can make the lines effective. Discuss with your students the levels of authority at your school and business (stockholders, board of directors, president, vice-presidents, plant managers, department heads, supervisors, workers).

A manufacturing enterprise has five managed areas of activity. These areas move a product from conception (idea) to completion (finished good). They are:

1. **research and development**—discovers, develops, and specifies new and improved products.
2. **production**—engineers manufacturing facilities and products to the company's quality standards.
3. **marketing**—identifies the people who will buy the products. Then marketing promotes, sells, and distributes it to them.
4. **industrial relations**—operates programs to find and train the company work force. It also promotes that which makes the public and workers feel good about the company.
5. **financial affairs**—raises and controls the company's money.

There are three types of ownership. Each one has its advantages and disadvantages. The three types are:

1. **Proprietorship**—business owned by one person.

2. **Partnership**—an association of two or more people to operate a legal business.

3. **Corporation**—legally created business unit owned by stockholders.

Several procedures must be done to form a corporation, such as articles of incorporation, corporate charter, and by-laws and developing a management structure.

Company management must have money to operate. Three sources for capital are available to companies:

1. Borrowing from a financial institution.

2. Plowbacks, which are portions of profit put back into the company.

3. Sell legal shares of the company (stocks).

The financial affairs area of management is in charge of raising and controlling the money of the company.

The company must determine financial needs, such as production cost (materials and tooling), marketing (advertising sales commissions, and packaging) and other costs. Once that need is determined, a certain number of shares are sold at a set price. Example: $100.00 (determined amount of financial need) divided by 100 shares (set number of shares), equals $1.00 per share. Sales of the stock shares will generate the money needed to produce the products. Stress to the students that their money plus a dividend (amount over the price per share) will be returned to them, if they produce a good product, eliminate waste, and sell all of the inventory. Dividend amounts vary with the amount of profit made. Be sure to clear stock sales with the school administrators.

Managers must control the company's money. Each transaction should be recorded. Income and expenses are entered into company ledgers. All monetary transactions should be documented. Keep an accurate record of who was involved (vendor, customer, sales person, stockholder), the date, and the amount. Always make two copies of records, and you should keep the original.

Students should now start thinking of their class as a company. Role-playing is an important element in being a successful company. Students should become aware that each position in the company is important.

OBJECTIVES

Upon completing this learning module, each student should be able to:

1. Define management.
2. List and describe the functions of management.
3. List and describe the duties of the common levels of management authority.
4. List and describe the five major managed areas of activity commonly found in a manufacturing enterprise.
5. List and discuss the common forms of ownership.
6. Discuss the steps in forming a corporation.
7. Define and describe the functions of financial affairs.
8. Discuss techniques used to determine the financial needs of a company.
9. Discuss the major sources of financing for a corporation.
10. List the three types of financial records maintained by a company.
11. List and describe the major types of budgets used by a company.
12. Describe general accounting records.
13. Describe the use of cost accounting.

CALENDAR

DAY	ACTIVITY
1	Introduce, give examples of, and discuss management systems. Discuss the seven essentials to successful manufacturing.
2	Introduce and discuss manufacturing organization structures and charts. Develop an organization structure for the student enterprise and hire employes.
3	Introduce and discuss the methods of financing an enterprise. Determine number and price of stock.
4	Discuss the types and need for financial records and statements. Start a general ledger.
5	Maintain production costs and marketing records.

PRESENTING THE MODULE

DAY	ACTIVITY
0	Before you introduce this module, develop or update your daily lesson plans, generate handouts, collect examples, select media and materials necessary to support your instruction, and determine activities capable of supporting the module content. Read several teacher resources and the student textbook. Some suggested readings are: Basic Manufacturing, pp. 118-129, 18-29 Exploring Manufacturing, pp. 127-142, 241-246 Intro to Manufacturing, pp. 244-262, 203-213 Manufacturing (Fales), pp. 134-136, 104-116 Manufacturing (Wright), pp. 177-188, 217-228, 87-124. Note: A bibliography is listed in the appendix. Also, keep current with other sources of information, such as magazines, professional publications, professional meetings, and other local school systems. Develop meaningful activities and experiences which will support the concepts of this module. An activity should not be lengthy, but a variety of activities should be presented to the students. Prepare activity sheets to facilitate better learning. Obtain and/or prepare materials for selected classroom and/or laboratory activities. Remember, this is a curriculum guide. Some modifications will be necessary to meet your specific needs. You should evaluate and update activities and instructional materials constantly.
1	Discuss and define management. All production systems have two types of processing. The first type was covered in Modules 2 through 9, Material Processing. The second type is the Process of Management. Management is an ongoing process, which has four distinct functions. They are: 1. **planning**—setting goals and course of action to be followed. 2. **organizing**—dividing tasks into jobs and establishing line of authority. 3. **directing**—assigning employees to jobs and encouraging them to complete their work. 4. **controlling**—comparing the results of employees' work with the company plan.

DAY	ACTIVITY
	Discuss the seven essentials to a successful manufacturing effort (people, machines, materials, money, management, methods, and markets).
	Discuss the levels of authority (stockholder to worker).
	Students should:
	Relate management concepts to life situations, such as a father or mother is a vice president of a company.
	Discuss changing management practice, such as improving workers' self-worth.
	Read and discuss "Ump's Fwat" activity or develop a management plan activity.
2	Discuss the need for an organizational structure.
	Review a proposed organization chart and discuss hiring procedures.
	Students should:
	Participate and develop their own organization chart through classroom interaction.
	Apply for a position.
3	Discuss the ways of financing an enterprise.
	1. equity financing (shareholder)
	2. debt financing (borrowing w/ interest).
	Show the 16 mm film, The Kingdom of Mocha, available from Modern Talking Pictures and Public Service Indiana.
	Discuss manufacturing cost of the selected product.
	1. material cost
	2. overhead
	3. marketing cost
	4. administration cost.
	Set number of shares (usually 100) and price per share.

DAY	ACTIVITY
	Students should:
	Develop a manufacturing cost estimate.
	Develop the cost per share of stock.
4	Discuss types and need for financial records and statements.
	1. budgets
	2. general accounts
	3. cost accounts.
	Start selling shares of stock. On the first day, allow an equal number of shares per student, then, the next day allow students to buy as many as possible (total limit 100). Keep stock sales to your classroom students and their families.
	Start a general ledger. It is important to keep all records and receipts. The instructor should always keep the original.
	Students should:
	Participate in buying shares in the company.
	Record on their general ledger any entries.
5	Day 3 actually carries over into production and marketing.
	1. record all payments and keep receipts
	2. purchase orders
	3. collect money from sales
	4. update (constantly) and complete general ledger
	5. complete a summary financial record.
	Students should:
	Record general ledger entries.
	Return sales receipts and money to the company.
	Develop a summary financial record.

APPENDIX

Instructional Materials:

1. Teacher developed and/or commercially available transparencies/slides/16 mm or video films/filmstrips/charts, describing management and the organizing of an enterprise. Some sample sources are:

   a. Modern Talking Picture Service

   b. Manufacturing Forum

   c. DCA Educational Products, Inc.

   d. Creative Learning Systems, Inc.

2. Developed or updated instructor's daily lesson plans.

3. Course syllabus.

4. Handouts and activity sheets on:

   a. the functions of management (planning, organizing, directing, and controlling). Develop a management plan

   b. organization chart for the classroom

   c. general ledger form

   d. stock certificate form

   e. stock purchase record form

   f. sales record form

   g. purchase order form.

Textbook Resources:

Fales, James, et.al., Manufacturing, A Basic Text for Industrial Arts, McKnight & McKnight Publishing Co., Bloomington, IL, (1980).

Jambro, Donald J., Introduction to Manufacturing, Delmar Publishing Co., Inc., Albany, NY, (1982).

Kruppa, and Lindbeck, Basic Manufacturing, Bennett & McKnight Publishing Co., Peoria, IL, (1985).

Wright, R. Thomas, Exploring Manufacturing, Goodheart-Willcox Co., Inc., South Holland, IL, (1985).

Wright, R. Thomas, Manufacturing: Material Processing, Management, Career, Goodheart-Willcox Co., Inc., South Holland, IL, (1976).

Publications:

Manufacturing Forum, Department of Industry and Technology, Ball State University, Muncie, IN 47306.

The Technology Teacher, 1919 Association Drive, Reston, VA 22091.

Ump's Fwat: An Annual Report for Young People, Figgie International, Inc., 1000 Virginia Center Parkway, Richmond, VA 23295, (804) 264-5600.

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Fales, James, et.al., Manufacturing: A Basic Text for Industrial Arts, Bennett & McKnight Publishing Co., Peoria, IL, (1980), (Textbook and Teacher's Guide): pp. 104-116, 134-136.

Wright, R. Thomas, Exploring Manufacturing, Goodheart-Willcox Co., South Holland, IL, (1985), (Textbook, Teacher's Guide, Student Manual, and Activity Sheets): pp. 127-142, 241-246.

REFERENCES

Jambro, Donald J., Introduction to Manufacturing, Delmar Publishing Co., Albany, NY, (1982).

Kazanas, et.al., Basic Manufacturing Processes, McGraw Hill Book Co., New York, (1981).

Wright, R. Thomas, Processes of Manufacturing, Goodheart-Willcox Co., South Holland, IL, (1987).

MODULE: 6 : Researching and Developing Products

LENGTH: 10 DAYS Manufacturing CLUSTER

Research and development is involved with converting ideas into specified products. It involves determining product needs, generating product ideas, refining and interpreting ideas, specifying product characteristics, and obtaining approval to produce developed products.

Companies use two types of approaches in developing products. A production approach is where a company develops a product, then, with the use of advertising, convinces consumers that they need the product. The consumer approach determines what the consumers want, then, they produce a product to meet that need. Product ideas are generated by studying consumers, competitors, and technological development.

The process of putting ideas onto paper is called ideation. When designing, a designer must keep three factors in mind. They design for function (purpose, operation, safety), manufacture (can it be built), and selling (function, appearance, value). In this module, the students are going to become designers. Each student will present an idea for a product to be manufactured, to the class (board of directors). From those ideas, a few (3-5) will be further developed and presented again for a final product approval.

Designers must follow some basic steps in developing ideas. They are as follows:

1. **preliminary designs**—thumbnail or rough sketches which are many in number, quickly done, and show few details. Sketching is an important and creative element in product development.

2. **refining designs**—the designer selects and combines ideas from the thumbnail sketches. The sketches are improved and details are added.

3. **preparing models**—mock-ups (appearance models) and prototypes (working models) are made to visualize the product idea(s).

4. **communicating designs**—models and drawings (renderings—colored pictorials) are gathered and organized to convey product ideas to management.

5. **obtaining approval for designs**—formal presentations with all the product information is presented to management for approval.

After the final design is approved, the product's detail must be specified. Final preparation for a product is product engineering. Product engineers specify product characteristics in three ways:

1. **engineering drawings**—examples are detail, assembly, and systems drawings.

2. **bill of materials**—a listing of parts, quantity needed, size of each part, and the types of materials used.

3. **specification sheets**--special needs of the product and quality standards.

At the beginning of this module, there are many different types of product ideas conceived by students. Be sure to set parameters (cost to make, laboratory equipment, etc.) before they start their designs. This will eliminate some problems in the future. Before designing, students should come up with a statement of a problem which they are trying to solve. Stress pride and quality in work. At the completion of this module, your class will have a product design ready for production.

OBJECTIVES

Upon completing this learning module, each student should be able to:

1. Describe the two major approaches to product development.
2. Describe techniques used to identify and evaluate product needs.
3. Discuss the sources of product ideas.
4. Discuss designing for manufacture, function, and selling.
5. Describe the typical product design process.
6. List and describe the three main documents used to communicate product characteristics.
7. List and describe the three main types of drawings used to specify the size and shape characteristics of a product.
8. Identify, develop, and communicate the specifications for a product.

CALENDAR

DAY	ACTIVITY
1	Discuss developing products for production. Identify and discuss the production and consumer approaches to product development.
2	Establish product criteria and a company profile.
3	Discuss how industry designs products for production and demonstrate the basic principles of sketching. Develop thumbnail and refined sketches.
4	Continue the development of proposed product sketches.
5	Conduct the first planning board activity.
6-7	Discuss and demonstrate the basic principles of engineering a product.
8-9	Discuss and conduct laboratory activities which reinforce the development of a bill of materials (for proposed products), cost estimates, and other elements of the planning board process.
10	Conduct the second planning board activity.

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PRESENTING THE MODULE

DAY	ACTIVITY
0	Before you introduce this module, develop or update your daily lesson plans, generate handouts, collect examples, select media and materials necessary to support your instruction, and determine activities capable of supporting the module content. Read several teacher resources and the student textbook. Some suggested readings are: Basic Manufacturing: pp. 30-41 Exploring Manufacturing: pp. 143-162 Intro. to Manufacturing: pp. 173-202 Manufacturing (Fales): pp. 69-102 Manufacturing (Wright): pp. 125-136. Note: A bibliography is listed in the appendix. Also, keep current with other sources of information such as magazines, professional publications, professional meetings and other local school systems. Develop meaningful activities and experiences which will support the concepts of this module. An activity should not be lengthy, but a variety of activities should be presented to the students. Prepare activity sheets to facilitate better learning. Obtain and/or prepare materials for selected classroom and laboratory activities. Remember, this is a curriculum guide. Some modifications will be necessary to meet your specific needs. You should evaluate and update activities and instructional materials constantly.
1	Discuss establishing product needs. There are two basic systems of developing product ideas—production approach and consumer approach. **Take Home Assignment**—Divide the class in half. One half of the class will take consumer and the other half production. Each student is to use a 14" x 18" posterboard and make a collage of pictures either showing consumer or production product ideas. Ideas can come from newspapers, magazines, catalogs, etc. Discuss the three sources of ideas: 1. **Consumers**—market survey and warranty card. 2. **Competitors**--competitive analysis. 3. **Technological Developments**—basic research.

DAY	ACTIVITY
	Show a filmstrip which deals with the development of product ideas. Example: "Developing Product Ideas," available through Manufacturing Forum.
2	Discuss establishing product criteria/company profile. Elements—type of market, type of products, sales volume, cost to develop, financial resources available.
	Show videotape "For Years to Come," available through Modern Talking Pictures.
	Develop a company/product profile for the class. Examples--number to be made (50-100 products) and cost to make (no more than $2.00).
	Have students develop a statement of a problem.
	Students should discuss, develop, and record a product criteria/company profile for the class.
	Develop a statement of the design problem.
3	Discuss the process of designing.
	1. Developing preliminary designs.
	2. Refining designs.
	3. Preparing models.
	4. Communicating designs.
	5. Obtaining approval for designs.
	Demonstrate principles of sketching.
	1. Thumbnail or rough sketches.
	2. Refine sketching.
	Pass out 1/4 grid graph paper and allow students to make rough sketches of product ideas.
	Students should:
	Participate in discussion and demonstration.
	Develop and prepare 10-15 rough sketches for product idea solutions.

DAY	ACTIVITY
4	Help students to change rough sketches into refined sketches. Students should have a library of five to ten ideas. They will reduce that library to their favorite solutions. Refined sketches should have details added and overall dimensions. Discuss the use of the first planning board to evaluate product ideas. Out of all of the product ideas, three to five will be chosen to be developed further. Students should: Prepare refined sketches of three to four ideas, then select the best solutions. Prepare a cost estimate. Participate in discussion about the first planning board.
5	Participate in first planning board. 1. If possible, arrange seats in a conference-like setting. (i.e., u-shaped). 2. Develop a product evaluation form. This helps students keep track of product ideas. 3. Use an opaque projector for presenting ideas 4. Select three to five products to be further developed. Number of ideas will depend on class size. Students should: 1. present their product ideas to the class 2. state the problems to be solved 3. show thumbnail sketches 4. show their refined designs. Evaluate products in four categories 1. design and appearances 2. market

DAY	ACTIVITY
	3. production
	4. financial.
	Cast a vote for the best idea.
6-7	Discuss engineering products.
	Specify products in three ways.
	1. engineering drawings
	2. bill of materials
	3. specification sheets.
	Demonstrate basic engineering drawings
	1. detail drawings
	2. assembly drawings
	3. systems drawings.
	Demonstrate a simple CAD system.
	Discuss engineering tasks to be completed as a group or design team.
	1. a new sketch of a product
	2. detail drawings and assembly (student could use a CAD system)
	3. a bill of material
	4. cost estimate
	5. market survey (50-100 taken)
	6. a competitive study
	7. make a prototype of the product idea.
	Assign students to different design groups.
	Students should:
	Observe demonstrations of basic engineering drawing techniques and practices. (Observe CAD system.)

DAY	ACTIVITY
	Record engineering task to be completed.
	Participate in brainstorming final design ideas.
8-9	Present small group discussions about topics, such as bill of materials, cost estimate, etc.
	Supervise classroom and laboratory activities.
	Participate in group and individual responsibilities:
	1. final sketches (pictorial)
	2. engineering drawings
	3. building a prototype
	4. bill of materials
	5. cost estimate
	6. market survey
	7. competitive study
	8. data summary sheet.
	Participate in small group meeting.
	Follow all safety rules.
10	Participate in the second planning board for final product approval. The design group will make their presentations. After all of the presentations, students will vote for a final product idea.
	The design group members will present their findings. Everyone should have a speaking part.
	At the end of the day, all of the material will be turned into the instructor, along with a list of individual responsibilities.
	The class, as a whole, will:
	1. evaluate other product ideas
	2. vote for best idea.

APPENDIX

Instructional Materials:

1. Teacher developed and/or commercially available transparencies/slides/16 mm or video films/filmstrips/charts, etc....describing the product design process, and basic drawing techniques. Some sample sources are:

   a. Modern Talking Picture Service

   b. Manufacturing Forum

   c. DCA Educational Products, Inc.

   d. Creative Learning Systems, Inc.

2. Developed or updated instructor's daily lesson plans.

3. Course syllabus.

4. Handouts and activity sheets on:

   a. filmstrip note sheet (aids students in taking notes by looking for specific points.)

   b. product criteria sheet

   c. statement of problem sheet w/ graph paper for product rough sketches

   d. product idea evaluation form

   e. information sheet with engineering drawing basics

   f. design group assigned task form (help with individual evaluation)

   g. graph paper for final sketches (engineering drawings)

   h. bill of materials form

   i. competitive analysis form

   j. market survey sample (best when group designs its own)

   k. cost analysis form.

Special Equipment and Supplies:

This varies due to a variety of product ideas. A heat strip helps when bending plastics.

APPENDIX

An opaque projector helps in showing ideas or findings during the managerial approval phase.

Safety equipment is necessary for observing and performing activities.

TEXTBOOKS

Fales, James, et.al., Manufacturing, A Basic Text for Industrial Arts, McKnight & McKnight Publishing Co., Bloomington, IL, 1980.

Jambro, Donald J., Introduction to Manufacturing, Delmar Publishing, Inc., Albany, NY, 1982.

Kruppa and Lindbeck, Basic Manufacturing, Bennett & McKnight Publishing Co., Peoria, IL, 1985.

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PUBLICATIONS

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TEXTBOOKS

Fales, James, et.al., Manufacturing: A Basic Text for Industrial Arts, Bennett & McKnight Publishing Co., Peoria, IL, 1985 (Textbook, Teacher's Guide): pp. 69-102.

Wright, R. Thomas, Exploring Manufacturing, Goodheart-Willcox Co., South Holland, IL, 1985 (Textbook, Teacher's Guide, Student Manual, and Activity Sheets): pp. 143-162.

REFERENCES

Jambro, Donald J., Introduction to Manufacturing, Delmar Publishing Co., Albany, NY, 1982.

Kazanas, et.al., Basic Manufacturing Processes, McGraw Hill Book Co., New York, 1981.

Wright, R. Thomas, Processes of Manufacturing, Goodheart-Willcox Co., South Holland, Il, 1987.

INTRODUCTION TO MANUFACTURING

MODULE: 7 : Producing Products

LENGTH: 17 DAYS Manufacturing CLUSTER

This module is a combination of the two activity areas of production and industrial relations. Production activities include selecting a manufacturing system, designing and engineering a production facility, purchasing material resources, and establishing various control systems. Industrial relations is in charge of employing and training, operating safety programs, and labor relations.

Choosing the correct type of manufacturing system is important to the efficiency of a company. The type of system is determined by the quantities and types of parts. There are three types of manufacturing systems.

1. **Custom Manufacturing**--few products produced according to customer's specifications.

2. **Intermittent Manufacturing**--several types of products or parts are produced at different periods of time.

3. **Continuous Manufacturing**--produces products in a steady flow.

Careful planning is needed in designing manufacturing facilities. There are five important tasks.

1. **Operation Selection**--Logically arranging the processes to efficiently produce products. Manufacturing engineers use three types of forms and methods:

   a. operation sheets

   b. flow process charts

   c. operation process charts.

2. **Design Tooling**—devices which hold or guide parts during machining to increase speed, accuracy, and safety during production.

3. **Plant Layout**—planning for the location of machines, aisles, and utilities for production in the plant. Material flow is also planned at this time.

4. **Designing Material-Handling Systems** (fixed or variable path)--Devices or systems which move materials, parts, or products from one location to the next.

5. **Efficiency Studies**--engineers are consistently reviewing and evaluating (time study) production systems to improve efficiency.

Student activities are set up to allow the students to develop their own production system. Students are to develop operations sheets, design the tooling, and plan a plant layout. Special projects for some students could be designing and building a material handling device (conveyor, etc.) or perform a time study on a particular operation.

During production, quality control stations should be set up to limit waste, maintain tolerances, and maintain product value. Quality control gauges and tooling should be made.

A work force must be developed for the production activities. Industrial relations must first determine employment needs. Each job in the production line needs to be titled, described, and listed for potential applicant to view. Job application should be designed, printed, passed out, and returned. Applicants should be matched with jobs and recruited. Each employe will find it necessary to move students to other areas. In small classes, students might have two or more jobs.

Before pilot run and production start, stress safety procedures to the class. It is a good idea to have students in industrial relations develop a safety program.

OBJECTIVES

Upon completing this learning module, each student should be able to:

1. List and describe the characteristics of the three commonly used manufacturing systems.
2. Describe the steps used in employing production workers.
3. Describe typical purchasing procedures.
4. Describe the procedures used in selecting and sequencing operations.
5. Discuss and develop a quality control system.
6. Develop a simple manufacturing system including the selection and sequencing of operations, designing a plant layout, and material-handling system, designing tooling and quality control system.
7. List and discuss the steps in producing a product.
8. Discuss the steps in production planning.
9. Differentiate between a pilot run and a production run.
10. Develop a safety program.
11. Describe the procedure used for organizing a union.
12. Describe the procedure for settling grievances.

CALENDAR

DAY	ACTIVITY
1-2	Discuss custom, intermittent, and continuous manufacturing production systems.
3	Discuss operation selection, tooling design, plant layout, material handling systems and studies, and time studies.
4-7	Discuss and develop flow process charts, operation process charts, jigs and fixtures, plant layouts, and material handling systems for the identified product.
8	Discuss obtaining human and material resources.
9-11	Discuss and develop methods of controlling the resources used in the production and the quality of the identified products.
12	Review the development of the manufacturing system.
13	Conduct pilot run of the manufacturing system.
14-16	Review and discuss the safety program and procedures. Conduct and supervise the production line activity.
17	Complete production, run a tear-down tooling, and clean laboratory.

PRESENTING THE MODULE

DAY	ACTIVITY
0	Before you introduce this module, develop or update your daily lesson plans, generate handouts, collect examples, select media and materials necessary to support your instruction, and determine activities capable of supporting the module content. Read several teacher resources and the student textbook. Some suggested readings are: Basic Manufacturing: pp. 56-107 Exploring Manufacturing: pp. 143-214 Intro. to Manufacturing: pp. 263-295, 225-243 Manufacturing (Fales): pp. 145-158 Manufacturing (Wright): pp. 137-150, 229-264. Note: A bibliography is listed in the appendix. Also, keep current with other sources of information such as magazines, professional publications, professional meetings, and other local school systems. Develop meaningful activities and experiences which will support the concepts of this module. An activity should not be lengthy, but a variety of activities should be presented to the students. Prepare activity sheets to facilitate better learning. Obtain and/or prepare materials for selected classroom and laboratory activities. Remember, this is a curriculum guide. Some modifications will be necessary to meet your specific needs. You should evaluate and update activities and instructional materials constantly.
1-2	Discuss the types of manufacturing systems: 1. custom 2. intermittent 3. continuous. Develop a simple product which can be custom and continuously produced. Assign some of the students to an assembly line (continuous), and the other students are to completely produce their own product. Compare the differences and the advantages and disadvantages between the two types of production systems. Example activity: Exploring Manufacturing, Guide, pp. 40-42 (Activity #20).

DAY	ACTIVITY
	Demonstrate operation sequence and safety precautions.
	Supervise the production.
	Students should observe demonstrations and record procedural and safety information.
	Participate in an activity of constructing a product by either custom or continuous production system.
	Participate in discussion about the advantages or disadvantages of the two systems.
	Discuss the production runs.
3	Discuss manufacturing engineering: manufacturing engineers are in charge of designing manufacturing facilities.
	1. operation selection
	2. tooling design
	3. plant layout
	4. material handling study
	5. time studies.
	Show filmstrips to illustrate developing production systems, available from manufacturing forum.
4	Discuss operation and flow process charts.
	1. flow process charts
	2. operation process charts.
	Lead discussion dealing with the flow and operation process charts for the class product.
	Discuss tooling needs. Define the difference between jigs and fixtures.
	Identify tooling needs for the class product.
	Show filmstrip dealing with tooling design, available through Manufacturing Forum.

DAY	ACTIVITY
	Discuss plant layout and material handling systems. **NOTE:** An enrichment activity for a student or a good number of students could be the development of a material handling system. Example activity—A conveyor system using coffee cans, upholstering webbing, and a hand crank or electric motor. Exploring Technology, Student Manual—Activities 4-5, pp. 89-90. Students should prepare a flow chart for a product. Prepare an operations process chart for a product. Determine tooling needs, design tooling to meet those needs, and build some tooling. Follow all safety rules. Develop a plant layout for the class product. **Extra:** Participate in making a material handling system.
8	Discuss obtaining human and material resources. **Human resources:** 1. determine need—jobs for class production 2. recruiting applicants—list job opportunities and descriptions 3. gather information—fill out job applications 4. selecting employes—job placement 5. train workers—pilot run. **Material resources:** 1. requisition materials—list materials needed for production 2. get bids or quotes—call lumber yard, etc., for latest prices 3. issue a purchase order—students prepare a purchase order 4. shipment and invoice—get materials and show bill of sale.

PRESENTING THE MODULE - Continued

DAY	ACTIVITY
	5. accept shipment—have student inspect materials
	6. pay for the materials.
	Students should:
	1. apply for a job by filling out an application
	2. prepare a purchase order.
9-11	Discuss control system phases.
	1. develop plan
	2. measure performance
	3. evaluate plan and performance
	4. correct plan and performance.
	Discuss controlling different types of resources.
	1. human
	2. machine or operation time
	3. materials.
	Discuss controlling quality.
	1. Motivation—have students develop a motivational poster.
	2. Inspection—have students build an inspection gauge and develop visual checks.
	3. Show filmstrip relating to quality control available through Manufacturing Forum.
	Students should:
	Determine and design inspection gauges.
	Help build inspection gauges and complete tooling at this time.
	Design a motivational poster.
12	Review the development of the manufacturing system.

PRESENTING THE MODULE

DAY	ACTIVITY
13	Discuss producing products. Run a pilot run to check: 1. plant layout 2. jigs and fixtures 3. inspection program 4. machine operation 5. safety program. The pilot run is designed to debug the production system. Students should participate in job placement and training, participate in pilot run, and evaluate and improve the production run.
14-16	Review and discuss safety programs and safety information. Run and supervise production line activity. Students should develop a safety poster, and perform in a production run and follow all safety procedures.
17	Complete production run. Tear down tooling and clean laboratory. Review and evaluate the production run. Students should: Participate in completing production activities. Review and evaluate the production run.

APPENDIX

Instructional Materials:

1. Teacher developed and/or commercially available transparencies/slides/16 mm or video films/filmstrips/charts, etc....describing manufacturing system and industrial relations. Some sample sources are:

   a. Modern Talking Picture Service

   b. Manufacturing Forum

   c. DCA Educational Products, Inc.

   d. Creative Learning Systems, Inc.

2. Developed or updated instructor's daily lesson plans.

3. Course syllabus.

4. Handouts and activity sheets on:

   a. filmstrip note sheets for

      (1) production systems

      (2) tooling needs

      (3) quality control

   b. operation flow charts

   c. tooling design sheets w/ grids

   d. inspection gauge sheets w/ grids

   e. job application

   f. purchase order form.

Special Equipment and Supplies:

1. Jig and fixtures for a simple product to show continuous vs. custom manufacturing.

2. Statco clamps for tooling (not necessary).

3. All productions can be done in a normal laboratory setting. If you have an older laboratory, try to make changes which will add flexibility. This will simplify production line problems.

4. Jigs and fixtures for classroom product.

5. Tool and machine usage will change with product ideas.

6. Posterboard, colored pencils, crayons, markers, and construction paper for posters.

7. Safety equipment necessary for observing and performing activities.

Textbook Resources:

Fales, James, et.al., Manufacturing, A Basic Text for Industrial Arts, McKnight & McKnight Publishing Co., Bloomington, IL, 1980.

Jambro, Donald J., Introduction to Manufacturing, Delmar Publishing, Inc., Albany, NY, 1962.

Kruppa and Lindbeck, Basic Manufacturing, Bennett & McKnight Publishing Co., Peoria, IL, 1985.

Wright, R. Thomas, Exploring Manufacturing, Goodheart-Willcox Co., Inc., South Holland, IL, 1985.

Wright, R. Thomas, Manufacturing: Material Processing, Management, Career, Goodheart-Willcox Co., Inc., South Holland, IL, 1976.

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Wright, R. Thomas, Exploring Manufacturing, Goodheart-Willcox Co., South Holland, IL, 1985 (Textbook, Teacher's Guide, Student Manual, and Activity Sheets): pp. 143-214.

REFERENCES

Jambro, Donald J., Introduction to Manufacturing, Delmar Publishing Co., Albany, NY, 1982.

Kazanas, et.al., Basic Manufacturing Processes, McGraw Hill Book Co., New York, 1981.

Wright, R. Thomas, Processes of Manufacturing, Goodheart-Willcox Co., South Holland, Il, 1987.

MODULE: 8 : Marketing the Products

LENGTH: 7 DAYS Manufacturing CLUSTER

This module introduces students to the broad area of marketing which encourages the flow of goods from producer to consumer. It involves developing marketing plans, promoting products through advertising and packaging, selling, distributing, and servicing products.

A complete marketing plan has five major elements:

1. **Product**—a company must have the right product to meet consumer needs or wants.

2. **Price**—the consumer must see value in the product.

3. **Promotion**—the consumer must be aware of the product and its features.

4. **Distribution**—the product must be available at the right time.

5. **Service**—the company must have a way to replace or repair their product.

One of the best ways of gathering information for a marketing plan is through the market research results. Use the market research survey results to answer: who will buy?, where are they located?, and how much will they pay? Using this information will also help in developing a trademark, and tradename, selecting a marketing theme, and pricing the product.

Two very important ways of promoting products are advertising and packaging. Advertisement usually promotes the company or the product. Advertisements can be made by following three basic steps. They are:

1. **The message is developed**—scripts are used for radio and television and copy for printed advertisements.

2. **The presentation is designed**—print advertising uses a presentation called a layout. Storyboards (a series of scenes in logical order) are used in television advertising.

3. **Advertisement is produced**—the message is taped or reproduced and released to the public.

Packaging serves three main functions for a company. Good packaging techniques can be a powerful force in consumer buying. The three functions are:

1. **protect and contain the product**

2. **promote the product**

3. **provide information for the consumer.**

INTRODUCTION - Continued

When developing a good sales program you must develop, a sales force (recruit), direct sales people (supervise and motivate), and control the sales activities (forecast and quotes). It will be important for your company to keep accurate sales records. A motivation for selling a product can be an award system like a sales commissions.

Products are broken into two categories which are nondurable or soft goods (life expectancy less than 3 years), and durable or hard goods (life expectancy
over three years). Companies need to provide operating procedures, servicing information, and warranties for their products.

Activities in this module should include development of a trademark and name, advertisement program (printed or recorded), a package with label, and a care and maintenance instructions sheet or tag for their product. Of course, these are suggestions. A good marketing program can sell products and create a good image of your course.

OBJECTIVES

Upon completing this learning module, each student should be able to:

1. Define marketing.
2. List and describe the elements of a marketing plan.
3. Differentiate between a tradename and a trademark.
4. Develop a trademark, tradename, and advertising theme.
5. Discuss the elements which affect product prices.
6. Discuss the two major types of advertisement.
7. Discuss the steps in developing advertisement.
8. Design a simple advertisement.
9. Discuss the functions of a package.
10. Describe the common types of packages.
11. Design a simple package.
12. Discuss types of sales.
13. Describe the steps in executing a sale.
14. Differentiate between maintenance and service.
15. Describe the product use cycle.
16. List and describe the steps in repairing a product.

CALENDAR

DAY	ACTIVITY
1-2	Discuss marketing and marketing plans.
	Develop a marketing system.
3-4	Discuss promoting products. Develop advertising and packaging procedures.
5	Discuss selling and servicing products.
6-7	Train sales staff and sell products.

PRESENTING THE MODULE

DAY	ACTIVITY
0	Before you introduce this module, develop or update your daily lesson plans, generate handouts, collect examples, select media and materials necessary to support your instruction, and determine activities capable of supporting the module content. Read several teacher resources and the student textbook. Some suggested readings are: Basic Manufacturing: pp. 107-117 Exploring Manufacturing: pp. 215-240 Intro. to Manufacturing: pp. 214-224 Manufacturing (Fales): pp. 159-173 Manufacturing (Wright): pp. 151-162, 259-264. Also, keep current with other sources of information such as magazines, professional publications, professional meetings and other local school systems. Develop meaningful activities and experiences which will support the concepts of this module. An activity should not be lengthy, but a variety of activities should be presented to the students. Prepare activity sheets to facilitate better learning. Obtain and/or prepare materials for selected classroom and laboratory activities. Remember, this is a curriculum guide. Some modifications will be necessary to meet your specific needs. Constantly, you should evaluate and update activities and instructional materials.
1-2	Discuss marketing and marketing plans. The five major elements to a plan are: 1. **product identification**—market research 2. **price**—cost of making and selling, competition, customers 3. **promotion**—tradename, mark, and theme 4. **distribution** 5. **service.** Show a filmstrip dealing with developing a trademark/name—available from Manufacturing Forum. Have the students develop a tradename and trademark for their company.

DAY	ACTIVITY

Discuss pricing the product with the students. Considerations:

1. manufacturing cost
2. marketing cost—commission and advertising
3. market research results.

Enrichment Activity—Have students run a break-even analysis program. Available for TRS-80 (Radio Shack computers).

Students should develop and prepare a tradename and trademark for the company, and participate in product pricing.

Enrichment Activity—View computer results of break-even analysis results.

3-4 Discuss promoting products.

1. Advertising:
   a. develop a message
   b. design a presentation
   c. the advertisement is produced.
2. Packaging:
   a. package type is selected
   b. graphics for the package designed
   c. package is printed.

Develop product promotional materials through these activities:

1. Printed Advertising
   a. posters—done by hand or signpress
   b. handbills—printed on ditto machine or using the "Print Shop" program for computers.
2. Advertise in a local newspaper.

DAY	ACTIVITY
	3. Radio or television commercial
	a. write an announcement for the P.A. system
	b. advertise on a local radio station
	c. videotape a commercial
	d. advertise on a "Swap Shop" or educational cable station.
	4. Packaging—have the students develop a simple package for their product.
	Students should:
	prepare and print advertisement
	prepare a radio or television commercial
	help design and prepare a package.
5	Discuss selling and servicing products.
	Develop a sales approach.
	Develop an owners manual.
	Prepare sales order forms.
	Students should:
	participate in the development of the sales approach
	prepare, print, and organize a sales booklet.
6-7	Train sales force.
	Sell products.
	Students should:
	participate in training the sales force
	participate in product sales
	return sales money (go to Financing Module).

APPENDIX

Instructional Materials:

1. Teacher developed and/or commercially available transparencies/slides/16 mm or video films/filmstrips/charts, etc....describing marketing techniques. Some sample sources are:

   a. Modern Talking Picture Service

   b. Manufacturing Forum

   c. DCA Educational Products, Inc.

   e. Creative Learning Systems, Inc.

2. Developed or updated instructor's daily lesson plans.

3. Course syllabus.

4. Handouts and activity sheets on:

   a. tradename and trademark design sheets

   b. print advertisement activity sheet

   c. radio commercial activity sheet

   d. packaging design sheet

   e. sales booklet form

   f. sales record form.

Special Equipment and Supplies:

1. posterboard, colored pencils, crayons, markers, and construction paper

2. signpress machine

3. polaroid camera

4. christmas lights, little electric motors, ICT for product displays

5. safety equipment necessary for observing and performing activities.

Textbook Resources:

Fales, James, et.al., Manufacturing, A Basic Text for Industrial Arts, McKnight & McKnight Publishing Co., Bloomington, IL, 1980.

Jambro, Donald J., Introduction to Manufacturing, Delmar Publishing, Inc., Albany, NY, 1982.

Kruppa and Lindbeck, Basic Manufacturing, Bennett & McKnight Publishing Co., Peoria, IL, 1985.

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MODULE: 9 : Synthesis

LENGTH: 3 DAYS Manufacturing CLUSTER

Synthesis, by definition, means the combining of parts or elements into a whole. Three important things must be covered in this module: (1) dissolving of the company, (2) review the main points during the past 18 weeks, and (3) evaluation of the students, course, and instructor.

The process of closing all company activities is called dissolution. Dissolution is caused by two types of action (voluntary or involuntary). The state or courts can close a company because of illegal acts or financial difficulties. This is called involuntary dissolution. Voluntary dissolution is when the owners decide to close on their own.

Your company will be making a voluntary dissolution. Financial affairs must pay off all debts and pay back the stockholders. The company charter must then be dissolved by filing a "Certificate of Dissolution." At this time, the students feel the financial awards of running a good company, or the financial punishment of running an inefficient company.

During the past 18 weeks, they have covered a lot of information. Take time to review the major points of manufacturing technology. Do some public relations work for your department by recruiting students for the other courses.

It sometimes appears that only the students are evaluated in school. Develop a semester final for the students, but also develop an evaluation form for the course and instructor. Use the responses for positive improvements in your course.

OBJECTIVES

Upon completing this learning module, each student should be able to:

1. Discuss the types of dissolution.
2. Describe the steps in dissolving a company.
3. Review the major points of manufacturing.
4. Evaluate personal achievement, course content, and instructor approach.

CALENDAR

DAY	ACTIVITY
1	Discuss the procedures for closing an enterprise.
2	Distribute commissions and dividends to stockholders.
3	Review the major concepts, processes, and systems studied during this course.

PRESENTING THE MODULE

DAY	ACTIVITY
0	Before you introduce this module, develop or update your daily lesson plans, generate handouts, collect examples, select media and materials necessary to support your instruction, and determine activities capable of supporting the module content. Read several teacher resources and the student textbook. Some suggested readings are: Basic Manufacturing: pp. 130-147 Exploring Manufacturing: pp. 247-252, 257-269 Intro. to Manufacturing: pp. 8-18 Manufacturing (Fales): pp. 35-37 Manufacturing (Wright): pp. 301-327. Also, keep current with other sources of information such as magazines, professional publications, professional meetings, and other local school systems. Develop meaningful activities and experiences which will support the concepts of this module. An activity should not be lengthy, but a variety of activities should be presented to the students. Prepare activity sheets to facilitate better learning. Obtain and/or prepare materials for selected classroom and laboratory activities. Remember, this is a curriculum guide. Some modifications will be necessary to meet your specific needs. You should evaluate and update activities and instructional materials constantly.
1	Discuss the procedures of closing an enterprise. The two basic types are: 1. **Voluntary Dissolution**—owners decide to close on their own. 2. **Involuntary Dissolution**—court orders the company to close because of bankruptcy or fraud. Complete the general ledger with the class. Complete an income summary statement. Fill out a "Certificate of Dissolution." Hold an official board meeting to vote for dissolution.

PRESENTING THE MODULE - Continued

DAY	ACTIVITY
	Students should complete their general ledger, fill out a "Certificate of Dissolution," and cast their votes for dissolution.
2	Distribute commission awards to salespersons.
	Distribute stock dividends to stockholders.
	Students should receive their sales commissions and dividends.
3	Review major concepts learned during the semester.
	Give students a final exam.
	Students evaluate course and instructor.
	Students should completle final exam, and objectively evaluate the course and instructor.

APPENDIX

Instructional Materials:

1. Teacher developed and/or commercially available transparencies/slides/16 mm or video films/filmstrips/charts, etc....describing closing an enterprise and manufacturing career. Some sample sources are:

   a. Modern Talking Picture Service

   b. Manufacturing Forum

   c. DCA Educational Products, Inc.

   d. Creative Learning Systems, Inc.

2. Developed or updated instructor's daily lesson plans.

3. Course syllabus.

4. Handouts and activity sheets on:

   a. income statement form

   b. articles of dissolution

   c. summary financial record.

   d. semester review sheet.

Textbook Resources:

Fales, James, et.al., Manufacturing, A Basic Text for Industrial Arts, McKnight & McKnight Publishing Co., Bloomington, IL, 1980.

Jambro, Donald J., Introduction to Manufacturing, Delmar Publishing Co., Inc., Albany, NY, 1982.

Kruppa and Lindbeck, Basic Manufacturing, Bennett & McKnight Publishing Co., Peoria, IL, 1985.

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Wrigh', R. Thomas, Manufacturing: Material Processing, Management, Career, Goodheart-Willcox, South Holland, IL, 1976.

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Kazanas, et.al., Basic Manufacturing Processes, McGraw Hill Book Co., New York, 1981.

Wright, R. Thomas, Processes of Manufacturing, Goodheart-Willcox Co., South Holland, Il, 1987.